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PUSA

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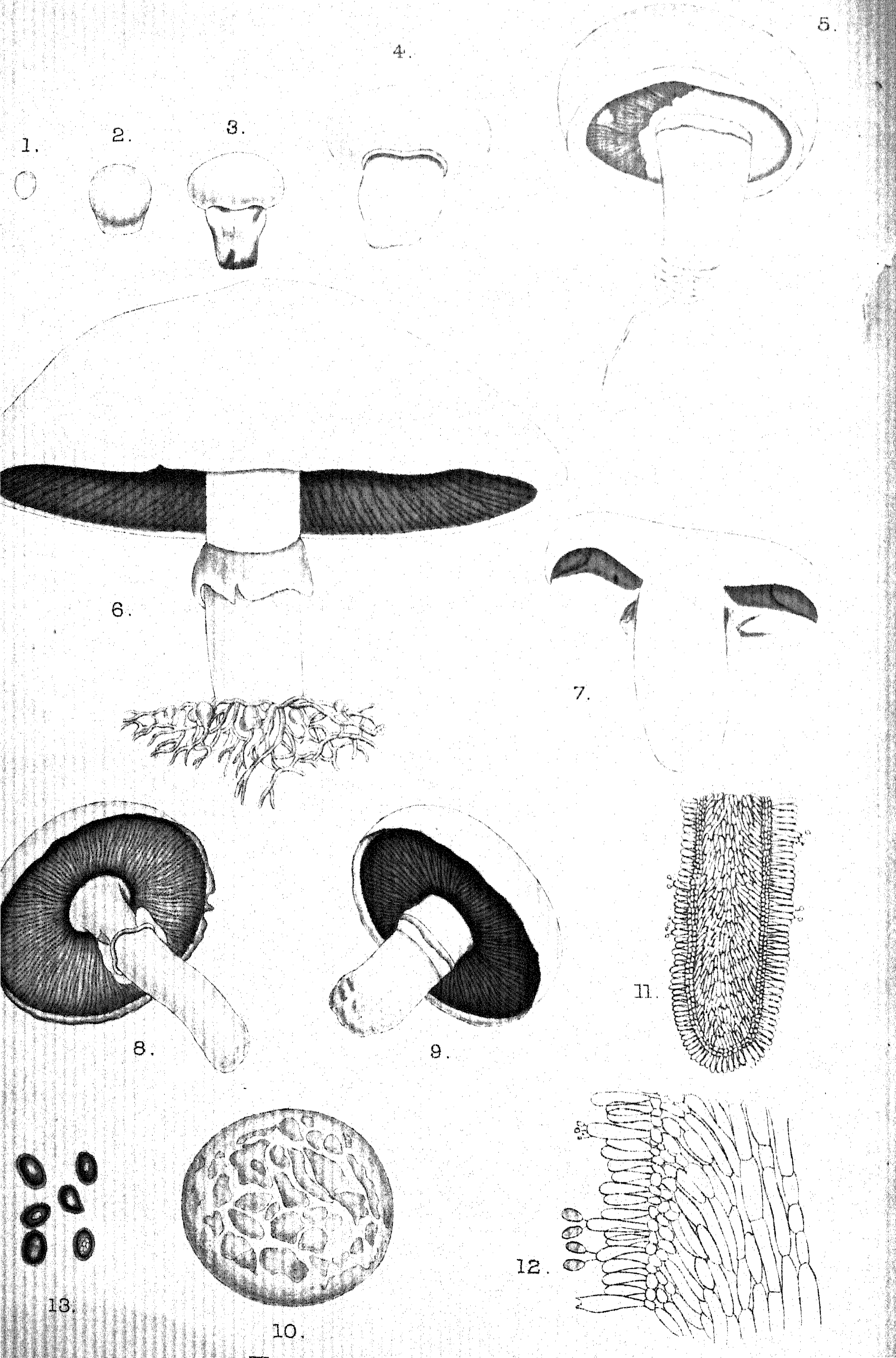
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Explanation of Plate XIV.

Edible mushroom, Agaricus campestris, Linn.

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Fig. 4. Cap swelling.

" 5. Cap well formed: veil bursting from the edge of the cap.

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THE EDIBLE MUSHROOM: *AGARICUS CAMPESTRIS*, LINN.

By W. McRAE, M.A., B.SC.,
Supernumerary Mycologist, Pusa.

After the first break in the rains when the air has become moist and steamy, countless fungi may be seen springing up everywhere throughout the jungle and on pastures, lawns and rubbish heaps. In places where decayed or decaying vegetable matter abounds, such as on an old stump of a tree, on an old log of wood, or in fields where cattle manure has been spread, these fungi find their most favoured habitat. Passing over those that attract us by their symmetry of form and beauty of colour, let us for a moment interest ourselves in those that are esteemed as articles of food.

The number of fungi that can be eaten without evil consequences is fairly large, and of these some have quite a pleasant flavour and are much appreciated. The best known one is the edible mushroom. Before describing this species more particularly, it might be better for us to have a brief account of the family to which it belongs in order that we may more easily understand the succeeding remarks upon distinguishing this particular species from others which are either of less culinary value or are even poisonous.

The mushroom is a member of the group of fungi called Agaricaceæ, whose common character is the possession of thin, flat, knife-like blades of tissue, called gills. Everyone knows the external appearance of a mushroom, a stalk bearing a cap on whose under-surface the gills are situated. The stalk may be attached to the centre of the cap, and the gills then radiate from the centre to the margin, or the stalk may be attached to

the side of the cap, and the gills then radiate outwards from this point.

All the gills extend from the edge of the cap right to the stalk, or only some do so. In the latter case some gills extend about two-thirds or one-half of the way towards the stalk, while others just extend inwards a very short way.

If we carefully remove some of the leaves and soil from the base of the stalk, there will be exposed a number of white threads, some thick and others thin, forming a tangled, felted network round the leaves and soil-particles somewhat after the manner of a stout spider's web. This is called botanically the mycelium; and in the common language of mushroom growers, the spawn. This is the part of the fungus that absorbs water and food from the decaying matter in the soil, while the part which we call the mushroom is simply the fruit of the fungus. The mycelium grows rapidly during wet weather and becomes well nourished, then at certain parts of its web young mushrooms are produced. It may, however, lie dormant in the soil during the hot weather, and whenever the soil becomes suitably moist on the advent of the rains, it begins its activity again. At certain places on the mycelium little rounded swellings may be seen, which vary in size from a pin head to a walnut. They gradually enlarge and break through the surface of the soil becoming what are called "buttons," which are simply the young unexpanded mushrooms. The outer coat of the button ruptures and exposes the young mushroom. Remnants of this coat may be left at the base of the stalk in the form of a cup, or there may be no trace of the coat left there. In addition, a thin veil of tissue may be drawn over the gills from the edge of the cap to the stalk, hiding them from sight, but it is torn before the spores are ripe (Plate XIV, fig. 5) and may leave a portion surrounding the stem in the form of an irregular ring, or the veil may entirely disappear leaving no trace of a ring. In the earlier stages growth goes on slowly, but, after the nodule is well formed and just before it breaks through the ground, the advent of a warm moist evening and night will cause the button to grow

at an enormous rate, and it usually requires only a single night for a button to burst through the surface of the ground and expand its cap. From the first beginnings of the swelling to the final maturity of the mushroom it occupies nearly a week, the exact time depending on the temperature and moisture of the air.

When ripe, the surfaces of the gills are covered with little round bodies called spores which correspond to the seeds of higher plants. If a fresh mushroom is taken and laid with its gills downwards on a piece of white paper for an hour or so, and then carefully lifted up, radiating lines of fine dust will remain upon the paper. This dust is composed of very minute spores that have fallen from the surfaces of the gills. The spores are the reproductive bodies of the plant, and, if placed in damp air on a soil containing suitable food, will germinate and send out fine colourless threads which eventually will grow into the mycelium that bears the mushroom heads. Each individual spore is so minute that it cannot be seen with the naked eye, but, when many of them lie together in a mass, they become visible. Their colour varies with the different kinds of agarics; it may be white, yellow, brown, purple or black.

Now that we know the general forms of the mushroom family, we shall study more minutely the characters of the one we are more particularly interested in, *viz.*, the edible mushroom, *Agaricus campestris.* The upper part of the cap of this species is somewhat flattened downwards, but it does not usually become quite flat. When in the button stage the cap is hemispherical. It is white or whitish in colour, and its surface may be either silky or dull. The skin of the cap can be easily peeled off. It often projects a little beyond the edge of the cap all round and is slightly folded inwards (Plate XIV, fig. 8), but in localities this is not so. The flesh is thick towards the middle of the cap and thin towards the rim (Plate XIV, fig. 7). The gills themselves do not actually touch the stalk, but are more or less free from it; they never are attached to it nor run down it. They lie close together and in the young condition are of a pale salmon-pink colour which soon changes to flesh colour, then light brown, becoming darker

and darker till of a deep dark brown. This discolouration is due to the rapid formation, all over the surface of the gills, of spores whose colour is purplish brown. When the spores are few, the gills appear pink, but as they rapidly increase in number, their colour becomes predominant, and the gills gradually become darker in tint. The cap is from 2 to 5 inches in diameter. The stalk is from 2 to 4 inches long and varies considerably in thickness. Some varieties have a stalk from $\frac{2}{3}$ to $\frac{1}{2}$ inch thick, while others, including the cultivated variety, reach a thickness of about an inch. The stalk is solid and consists of firm tissue towards the outside and loose felt-like tissue in the interior. A thick, fixed ring always surrounds the stalk and is usually situated above the middle.

There is a considerable amount of variation in the colour and thickness of both cultivated and wild mushrooms. The skin is often smooth and dull white, but it may be very slightly rough or even checked and have a light brown tinge which deepens in tint after the mushrooms have been plucked an hour or two. The mushroom gathered for the table is usually from 2 to 3 inches in diameter with a stalk about 2 or 3 inches high and $\frac{3}{4}$ inch thick. In some rich pastures, however, varieties and individuals occur of a larger size. Though harmless, these larger varieties are somewhat coarse and indigestible and are not counted such delicacies as the smaller ones. Indeed, the stage at which they are supposed to possess the most delicate flavour is when they have just burst open the veil, and the pink gills become visible (Plate XIV, fig. 5). The odour of fresh mushrooms is very slight and is rather pleasant; often, however, the odour is quite imperceptible.

The edible mushroom occurs most frequently on lawns, in pastures and especially in weedy fields. It never grows in woods except in open grassy glades, nor does it occur on or near stumps of trees.

Mushrooms should be gathered in the early morning and, as they are particularly liable to the attention of insects, it is advisable they should be cooked and eaten soon afterwards.

They should be cut sufficiently far above ground to escape all signs of dirt on the stalks. The mushrooms should then be laid stalk upwards in a basket, and if many are to be gathered, it is well to have several movable shelves to the basket so as to take off the strain of their weight and prevent their being crushed. Care should be taken to reject such as have become burrowed by fly larvæ or beetles. It is easy to determine whether a mushroom is wormy or not by breaking off the stem close to the cap and observing if there are little holes through which the larvæ have passed upwards into the caps. But, of course, on this score one must not be over-particular, for almost every mushroom, long before it has expanded, has been charged by flies and gnats with a store of eggs which will manifest themselves only too obviously if the mushrooms be kept a few hours too long without being cooked, when they degenerate into a black slimy mass full of wriggling white larvæ. When mushrooms, however, in the fair and pleasant stage are well cooked, what eggs may be present are rendered quite harmless.

Characters of an edible mushroom :—

It grows on grassy places or on rubbish heaps.

It is of small size (2 to 4 inches across the cap).

The gills are free from the stem, and at first are pink in colour.

The spores are deep purple black or dark brown.

The stalk is solid and has a fixed ring.

These characters must all be taken together, and unless a species of mushroom has all of them, it is probably not the ordinary edible mushroom. The foregoing description with the plate shown will be sufficient to enable anyone to decide whether a given species of mushroom is the common edible one or not. Of course, several other members of the mushroom family are edible or harmless, but we leave them out of account at present. A few general hints may now be given which will enable one to avoid poisonous ones, though by following them one will also exclude many that are edible.

1. Avoid every mushroom having a cap or suggestion of a cap, at the base of the stalk. The distinctly poisonous ones are thus excluded.

2. Reject those having an unpleasant odour, a bitter or unpalatable flavour or a tough consistency.

3. Reject those with a milky juice. Several species of this kind are edible, but they ought to be known thoroughly before being classed as such.

4. Reject those that are very brittle and whose gills are nearly all of equal length, when the flesh of the cap is thin and especially when the cap itself is of a bright colour.

5. Be careful to choose buttons that are not deep-seated in the soil but are at the surface.

6. Exclude those infected with worms or that have begun to decay.

The following is, perhaps, the most general way of cooking mushrooms. Peel off the skin, remove the stalks and place in a *degchi* with butter and let them stew over a brisk fire; when the butter has melted, squeeze in the juice of a lemon; after a while add salt, pepper and spice. Let them simmer for about half an hour and then add yolk of egg to bind them: then pour over some pieces of toast or bread previously fried in butter. They may also be made into soup, omelette or pudding, and a cook will easily think of other or more savoury ways of dressing them so as to bring out their peculiar flavour and aroma.

One sometimes hears it stated that mushrooms constitute a wholesome and delicious food of high nutrient value, but chemical analysis hardly bears this out. The composition of the common mushroom is shown in the following table:—

Water	91·30		91·98	
Protein	2·25		2·69	
Total nitrogen		·60		·67
Albuminoid nitrogen ...		·36		·43
Non-albuminoid nitrogen ...		·24		·24
Fat	·20		·17	
Carbohydrates	4·95		3·23	
Fibre	·80		·61	
Ash	·50		1·32	

The first analysis is taken from U. S. Dept. of Agriculture, Farmer's Bulletin No. 79, and the second was made at Pusa under the direction of Mr. H. E. Annett. From this it is evident that the mushroom consists largely of water with only small quantities of protein, fat, and carbohydrates and must be regarded more as an excellent condiment than as a nutritious food.

France is the country in which the cultivation of mushrooms is carried on most extensively. In the region round Paris there are old building-stone quarries with tunnels and caves often miles in extent and reaching to a considerable depth below ground. On the floors of these tunnels well-rotted stable manure is laid and sown with mushroom spawn. The air is kept constantly damp, but well-ventilated and good crops are raised. About six pounds of mushrooms per square yard is considered a good yield. In 1901, almost 125,000 maunds of mushrooms were sold in the central market of Paris. Of this quantity about one-third was consumed in the fresh state throughout the city, while the rest was preserved as tinned mushrooms or was used in the preparation of ketchup. These figures indicate convincingly the extent of the mushroom industry in Paris. Edible mushrooms are found in other parts of the world besides Europe. "In many parts of India, especially the Punjab, the true mushroom is abundant in the fields. It is universally eaten by the natives, fresh or dried in the sun. It is apparently a very common plant in Afghanistan."* "The common mushroom," says Dr. Stewart, "is abundant in cattle-fields in many parts of the central Punjab after the rains, and is also frequent in the desert tracts of central and southern Punjab. It is largely eaten by the natives, and is described as excellent and equal to the English mushroom by those Europeans who have eaten it. It is also extensively dried for future consumption, and is said to preserve its flavour tolerably well. Mushrooms are largely used in Europe in the manufacture of ketchup. A trade in Punjab mushrooms might pos-

* Watt's *Dictionary of Economic Products of India.* FUNGI, p. 131.

sibly be established were they to be improved in quality by cultivation."

There might be a very good market for the fresh article in a few of the larger cities in India, if the product became a certain factor on the market. Further enquiries will be made on this subject, both with regard to the mushrooms both of the ordinary edible variety we have just spoken about, and also other edible varieties such as the truffles, morells, and puffballs.

Explanation of Plate XV.

Hairy Caterpillars on Cumbu (Pennisetum typhoideum).

The full-grown caterpillars and the moth in the resting attitude are shown on the plant, the chrysalis and moth at the side.

HAIRY CATERPILLARS IN THE SOUTH ARCOT DISTRICT, MADRAS.

By Y. RAMACHANDRA RAO,

Assistant in Entomology, College of Agriculture, Coimbatore, Madras.

Hairy caterpillars, locally known as "kambli-puchis," are of common occurrence in the South Arcot District. "Kambli-puchi" is, however, a generic term applicable to caterpillars with a woolly coat belonging to several different families of moths, such as the Lymantriids, Lasiocampids and Arctiids, but according to general usage the term seems to be restricted to the following injurious species of the sub-family Arctiinæ, *viz.* :—*Pericallia ricini*, *Amsacta lactinea*, *A. albistriga* and *A. moorei*. The first—*Pericallia ricini*—is chiefly a pest of vegetable gardens, attacking castor, *agathi*, plantain, sunflower and the various kinds of gourds. The second, *Amsacta lactinea*, does not usually occur in considerable numbers. It is generally the last two species that are responsible for the great and yearly damage sustained by the crops.

Along the southern bank of the Gadilam river there stretches a low table land, several miles wide, of poor red soil, differing markedly in character from the rich alluvial clay to the north of the river. The plateau is made up mostly of a very stiff red clay loam of great thickness, resting on a substratum of gravel. The surface layer has, owing to the effects of weathering and cultivation, assumed a soft and sandy character. The chief crops cultivated are *cumbu* (*Pennisetum typhoideum*) and groundnut. Red gram, castor and pulses are the only other crops raised and are generally grown along the borders of *cumbu* fields. Thunder-showers received in May and early June are utilised for

ploughing, and in the monsoon showers at the end of June and during July, *cumbu* and groundnut are sown. Sometimes *cumbu* and groundnut may be grown separately, but in the generality of cases *cumbu* is raised first, and when the crop is about a month old, groundnut is dibbled in during the second hoeing. Weeding is given only twice to the *cumbu* crop—the first 15 days after sowing and a second a fortnight later combined with groundnut dibbling. The millet is harvested in about two months and-a-half, and groundnut and pulses remain on the field for about two or three months more.

This tract is one of the ideal homes of the hairy caterpillar in South Arcot. The pest here appears regularly every year and attacks both *cumbu* and groundnut. Increasing enormously in certain years, it does immense damage to the crops.

1. *Life History.*—Two species are concerned in the attack, *viz.:—Amsacta albistriga* and *A. moorei*. *Amsacta albistriga* is a moth of moderate size. The forewings are pale brown with a few white streaks, and the hindwings are white with black spots. There is a yellow band on the head, as also a yellow streak along the anterior edge of the forewing. The upper surface of the body is yellow with dorsal and central series of black spots; the lower surface is dull white. In the other species yellow, wherever it occurs in the first species, is replaced by crimson, but otherwise both the species resemble each other. It is, however, evident that they are separate since the one has never been noted pairing with the other. However, as the eggs, caterpillars and pupæ as well as their habits, are quite similar, their life-histories can be considered together.

These moths generally lay on an average 600—700 eggs each, but in one case a single moth was noted to have laid 1,232 eggs in the course of four days. The eggs are globular in shape and bright yellow in colour, and are laid in flat masses on the lower surface of leaves in the case of *cumbu*, and on the lower or upper surface indifferently in the case of groundnut and species of *Sida* (weeds common in waste lands and fields). They are also laid on some of the grasses and on castor leaves.

They hatch in 3—4 days into tiny caterpillars of dark gray colour which first feed together in a group on the green matter of the leaves on which they happen to hatch out and reduce them to papery tissue. On finishing them they seek out other leaves. As they grow in size they begin to move about in search of food. Young caterpillars of a week or two weeks' growth are generally of a brownish black colour with a faint interrupted yellow line along the middle of the back. Older ones turn reddish-brown with black patches at either end of the body. Some specimens are, however, wholly red brown without any black patches. The full-grown caterpillar is about 2 inches in length, and is a very active creature, capable of moving long distances in search of food (Plate XV). In a carefully observed case ten moults were noted to be undergone from the time of hatching to pupation. Under artificial conditions in the breeding cages the caterpillar period was found to range between 42 and 50 days, but in nature the duration may be considerably less. When full-grown, the caterpillars, taking advantage of a timely rain, seek out places with a soft and loose soil in the field bunds and burrow down to a depth of 4 to 7 inches. There they prepare cocoons, change to chrysalides and lie quiescent in most cases, awaiting the rains of next July. In some cases, however, they may emerge as moths in about a fortnight, so as to give rise to a second generation during the year (Plate XV).

The moths have been observed to mate on the very night of emergence, after which the male generally dies. The female lays eggs on the 2nd, 3rd, and sometimes even on the 4th night after emergence and is then dead.

2. *Time of Emergence of Moths.*—In South Arcot the south-west monsoon makes itself felt mostly as a series of thunder-showers, varying in amount from $\frac{1}{4}$ inch to 3 inches received generally towards sunset. By the beginning of July the ground is thoroughly wetted, and pupæ begin to develop gradually into moths. According to the present year's experience they seem to be ready to emerge by the 3rd week of July and seem to await for a pretty heavy rain for rendering the soil soft enough

to allow them to come up. The moths emerge on the first or the second night following such heavy showers.

During the year 1909, a heavy rain amounting to about 1 inch was received at the village of Panicuppam, on the night of 22nd July, and the next night about 200 moths were trapped at a single light trap set up. The emergence was not, however, of any considerable extent. Later on, on the 8th August a fall of rain amounting to about $1\frac{1}{2}$ inches was received at about 8 P.M. Large numbers of moths were noted to emerge from the soil at about 4-30 P.M. on the next day but one, *i.e.*, on the 10th August. It may, therefore, be noted that the pest emerged in two separate batches in 1909, but it is not certain whether such is the case every year.

3. *Natural Enemies.*—A tachinid fly and a small braconid wasp have been reared from the caterpillars.

No birds have been noted preying upon this pest.

4. *Remedial Measures.*—1. The egg-masses are well known to the ryots of this tract, and advantage can be taken of the two weedings given to the *cumbu* and groundnut crops for picking out the egg-masses and just-hatched caterpillars.

2. In a virulent attack trenches may be dug to prevent the caterpillars from marching from field to field.

3. The pupæ generally occur together in large numbers at a depth of between 4 and 7 inches at the base of live hedges in field bunds or under trees. A hand hoe is sufficient to expose them, and if the *ryot* makes it a point to search for and destroy them before commencing sowing, a good deal of future trouble would be saved.

4. The *ryots* of this tract generally know by experience when the pest will emerge. It generally appears during the latter half of July or the first half of August on the first or the second night following a tolerably heavy fall of rain. For about a week following the day of heavy rain a light trap should be set up in each field and kept burning from 7 P.M. to 6 A.M., when the moths that have emerged will be attracted to the light and be killed. The light trap consists of (1) a glass-sided tin lamp

fed with a mixture of kerosene and cocoanut oil for attracting the moths; and (2) a wide tin tray filled with water and a little kerosene for trapping them. The tray is placed on a slightly elevated place in the fields, such as a heap of earth, and the lamp is either suspended over it by means of a separate stand or, more simply, placed over a stone in the middle of the tray.

With mutual co-operation among the *ryots* the pest can, by the adoption of the light trap method, be effectively kept in check in places where it appears year after year.

5. *Light Trap Experiments and Results.*—Panicuppam is a small village in the Cuddalore Taluk of South Arcot, and is about 2 miles from Panruti and 8 miles from the Palur Agricultural Station. Most of the inhabitants are Roman Catholic Christians, and there is a small church in the village, until lately looked after by the Rev. Mr. Prudent. Being the place whence the pest was originally reported, the light trap experiments were located in that village.

In order to have a fair trial of the efficacy of light traps the following arrangements were made in December 1908 by the Government Botanist in consultation with the Deputy Director of Agriculture, Southern Division. Several sets of light traps of as simple and inexpensive a nature as possible were to be ready, packed at the Palur farm, for being removed to the locality at a moment's notice. Immediate information of the emergence of moths was to be arranged for with the *ryots* at Panicuppam, on receipt of which an Assistant Manager was to set out for the scene of action and attend to the experiments until an Assistant from Coimbatore relieved him.

6. *The First Emergence.*—According to the above arrangement, the appearance of moths was reported to the Palur Farm Manager on the 24th July by the headman of Panicuppam ; and an Assistant Manager was sent to the village at once with 9 sets of traps, and an Assistant was also wired for from Coimbatore. On July 22nd, a heavy shower amounting to 1 inch was received in the village.

On 23rd July, night, in a single trap set up by the Rev. Mr. Prudent, 200 moths were noted.

On 24th July, night, 9 traps were set up by the Assistant Manager with the following results: 42, 10, 22, 25, 6, 8, 25, 6, and 11, making 155 in all.

On 25th July, night, 6 more lights were added, making in all 15. The following is a statement of results from the 25th to the 29th:—

Date.	Number of moths trapped.															Total of each day.	Remarks.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV		
July 25, night ..	6	4	3	..	3	1	2	6	..	..	..	4	4	..	..	33	
„ 26 „ ..	6	3	4	..	2	1	..	..	..	..	..	..	1	..	..	17	
„ 27 „ ..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	2	Moonlit nights.
„ 28 „ ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
„ 29 „ ..	..	..	1	..	..	..	...	..	..	..	..	..	..	..	..	1	

It is thus seen that the emergence was not of any considerable extent; in spite of 200 moths obtained on the first night and 155 in all on the second, the catches diminished very rapidly later on until on the 28th no moth was trapped. The experiment was, therefore, stopped; and as there were numbers of pupæ yet unhatched in the soil, and as the people were of opinion that another emergence would soon occur, the light traps were left under the custody of the village *monigar*, with instructions to set them up after the very next heavy shower and report the matter to the Palur farm manager.

7. *The Second Emergence.*—According to the report of the *monigar*, on August 8th, at about 8 P.M., a shower amounting to $1\frac{1}{2}$ inch was received.

On August 9th, night, in traps set up during the night, about 10—12 moths were found at each light.

On August 10th, numbers of moths were found emerging from the soil, from 4-30 P.M. onwards, and the lights were forthwith set up.

An Assistant Manager proceeded from the Palur farm and looked after the experiments. The following are the results reported by him :—

Date.	Number of moths trapped.															Total of each day.	REMARKS.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV		
August 10, night ..	75	300	450	700	150	1,300	96	600	100	Not	set	up	Not	set	up	3,771	
,, 11 ,, ..	12	200	200	64	170	50	400	120	200	150	70	..	..	..	..	1,636	
,, 12 ,, ..	20	75	200	250	200	120	200	150	175	30	2	1	100	..	2	1,525	
,, 13 ,, ..	2	5	55	90	1	3	15	60	12	73	30	13	75	25	100	559	

The Assistant Manager also reported that no moths were to be found in the neighbourhood of all those places where light traps had been set up, and that this fact convinced some of the *ryots* that in case lights could be set up all over the tract, the pest might even be exterminated altogether.

8. *Cost of the Apparatus.*—

	As.
The tin lamp with glass sides	8
The tin tray	6

Cost of lighting for each day comes to about 9 pies per lamp.

SCHOOL GARDENS.

By M. E. COUCHMAN, I.C.S.,
Director of Agriculture, Madras.

In connection with the annual "College Day" celebration, Mr. M. E. Couchman, I.C.S., Director of Agriculture, Madras, delivered an interesting and instructive address on "School Gardens" to the students of the Madras Teachers' College at Saidapet. In the course of his address he said:—

"The general ground on which I base my appeal for more school gardens is, I need hardly tell you, that I regard the Educational Department as an undeveloped adjunct of the more important Department of Agriculture. In order that the Agricultural Department may experience less difficulty in persuading the next generation of cultivators to adopt more up-to-date methods in their cultivation, the Educational Department must make the first approaches when they are young, when, as your syllabus says, the habits of thought, feeling and action are formed, and when perception, observation, and attention are likely to be most active. In no other calling are these qualities more necessary than in that of a farmer. In no other profession is the error of confounding the process of passing examinations with the acquisition of real knowledge more likely to lead to disappointment, if not disaster. I shall arrange the remarks which I am going to make to-night under two general heads: first, the reasons why more and better school gardens are desirable in Madras, and second, what they should and should not try to do and be.

"There are two main defects in the mental equipment of the educated classes of this country, so widely spread that I might almost go so far as to call them national characteristics—

the habit of identifying book-learning with knowledge, and the want of observation of, and the general indifference to, external nature. When you ask a man what he has learnt, he usually tells what standard he has studied up to, or what examinations he has passed, not what he knows. Knowledge seems to be almost regarded as a means to an end, *i.e.*, to the obtaining of a certificate. Hence we see such strange cases as men, who have studied Botany or any of the other natural sciences, going on to the study of law, with the intention of following the profession of *vakils*. And when you ask any one how he likes a new place of residence, the reasons which he gives for liking or disliking it, when they are not closely connected with his health, such as the food and water, are usually limited to the cost of living or the conveniences available for the education of his children. In a similar case the European would usually give at least some place to the natural amenities of the locality. As regards the habit of confusing book-knowledge with knowledge in the proper sense of the word, I would first point out that words are only symbols of reality. In particular, the natural sciences have no meaning or interest apart from the material world of nature, whose properties and movements they describe. To study any of the physical sciences, therefore, without connecting them at every step with reality, is a mere waste of time.

"In the past few years I have been brought in contact with men who have had some training in physical science, and I have noticed that it is not an uncommon thing to find that they have not really connected the sciences they have learnt with the real world. Their interest in science ceased with the class room, or rather with the examination room. During the rest of their lives they have been witnessing and taking part in a continuous series of chemical and biological experiments, without being aware of the fact at all, reminding one of the man who was surprised and delighted to be told that he had been talking prose all his life without knowing it.

"Now in the case of the school garden, this point of view is very clear. It affords a ready means of connecting the study of

elementary physical science with the realities which the books deal with. It forms a bridge from the theory of botany, chemistry, and physics to the real world; to those fields in which the parents of your future students toil to gain their living. If I were to go further, and discuss the methods of nature study, as it is called, I should be venturing out of my depth. The Madras scheme of studies for Elementary schools for boys summarises the aims of nature study as follows :—'Instruction proceeds from study of the actual object rather than from description or reading. The aim is not so much to impart information as to lead the children to find out for themselves all that they can about familiar and natural phenomena.'

"Much might be said on the second point, the strange indifference of educated Indians to external nature and the beauties of their own country. This may be due in part to the attraction which metaphysics has always had for the Indian mind, to the exclusion of interest in the world of nature. I should be the last person to deny the importance of metaphysics, but in the *Kaliyuga* in which we are living we are under the necessity of taking our part in the drama of this world, or farce, if such it is, and therefore we cannot afford to ignore the world in which we live. On the other hand, this indifference may have a less exalted source. It may be simply due to neglected and undeveloped powers of the mind. Among the characteristics of infancy and childhood enumerated in your syllabus are 'impressibility, imitativeness, and memory.' The mind of the child attending an Elementary school could not fail to be impressed with the appearance of a good school garden. He would wish to have a small garden of his own at home, and the habit of looking at and attending to a garden might stick to him all through his life. One of the most incongruous things about the residences of many wealthy Indians, at all events of this Presidency, is the contrast between the scrupulous care and attention paid to their personal cleanliness and personal appearance, and the squalor of the land surrounding their houses, which might be a garden, but which it would be flattery to describe as anything better than a piece of waste land enclosed by

a wall. It would be no small gain if the habits of neatness, order, and a taste for beautiful surroundings could be inculcated in the mind of the child when he goes to school.

" A taste for a garden is not a mere hobby, to be put on a plane with photography, or any game or amusement. Looked at from the most practical point of view, it would add greatly to the pleasure of life if those who had the time and money to do so, would beautify their surroundings, and bring pressure to bear on those entrusted with the care of public places to make them less unsightly than they are at present. How many Jubilee Parks and Queen Victoria Memorial Gardens in this country would then be placed where the public could recreate themselves in their spare moments with the sight of well-kept and beautiful grounds. At present in too many cases these places are neglected wastes, if nothing worse. From the public point of view, then, there is a good deal to be said in favour of any attempt to arouse more interest in gardening. From the point of view of the individual, gardening provides a pleasant recreation, and gives an interesting and harmless occupation to those who have nothing to do with their spare time. Everyone who has any knowledge of village life in this country knows that the want of occupation during the season when there is no field work going on is the main cause for half of the petty intrigues and criminal and civil disputes which flourish in the off season. I suggest that a taste for gardening inculcated in the children of the village might lead to a diminution of these mischievous quarrels, which are the bane of Indian life. There is such a thing as a too exclusive attention to the affairs of one's neighbours. It is true that the proper study of mankind is man, but there are other objects which repay attention. Without going so far as the famous Head of a Cambridge College who is reported to have said, after attending a long and acrimonious College meeting, 'the more I see of men, the more I like dogs,' there can be no doubt that one strong argument for gardening is that it constitutes an occupation free from the envy, hatred and uncharitableness which are

too commonly the fruit of seeing too much of our fellow-creatures.

"Passing on to the second division of the subject, the discussion of the question of what school gardens ought to be, and what they ought to aim at doing, we are met at once with a good deal of diversity of views. There are some who will say that merely growing ornamental plants or flowers is no use, because most of the boys at the village schools in this country will have to spend their lives in following the plough, and farmers are notoriously indifferent to gardening, and have little time for it.

"Again, if it is suggested that the staple crop of the village should be cultivated in a superior fashion in the school garden, the objection is put forward that this will teach the boys nothing, because the high manuring and cultivation possible on a small scale cannot be followed in a field. If, to meet this objection, you suggest that a fair-sized field should be hired or borrowed and the local crops grown under ordinary field conditions, it is said the schoolmaster will be less successful in his cultivation than the local *ryots*, because he is devoid of their experience, and that the failure which he is certain to meet with will bring on him the ridicule of the village.

"Before discussing these alternatives, there are one or two points which might be laid down. The first is that the schoolmaster should be very cautious about recommending any practical change in ordinary cultivation to the *ryot*. Apart altogether from the art of growing of plants or animals, farming is a money-making profession, and without long practical experience it is not possible for any amateur, whatever his knowledge of science, or even of practical gardening may be, to say what will pay on a field scale. Yet, in as much as in many villages the schoolmaster is the only educated person, the Agricultural Department cannot afford to take no steps to use him for the improvement of the village agriculture. With this intention, we issue our *Agricultural Calendar* every year, and try to supply every schoolmaster with a copy. This contains practical advice on well-tested improvements, which may be safely recommended to the *ryots*.

I would ask as a special favour of all the members of the Educational Department present to-night that they should see that every school has a copy of this calendar, and that they should use their influence to get the schoolmasters to read it and discuss the subjects dealt in it with the people. Each article is signed, and the writer will be very pleased to give any further information regarding any point which is not clear. In fact, one of our main objects in issuing the calendar is to encourage people to write to us on agricultural matters.

"Another error which should be avoided in school gardens is the attempt to grow plants whose natural habitat is outside the tropics. If the plants grow at all, they will be sickly, stunted things, and will give the children an altogether wrong idea of the nature of the plant in its own home. In a school garden on the West Coast I have seen wheat growing, but it was such a wretched specimen that I did not at first recognise it at all. Such experiments are worse than useless, because they confirm the ignorant belief of the people in the superiority of their own crops to those of other countries. This does not mean that the garden should contain nothing new to the village. In many parts of the Presidency at the present time, groundnuts are now being introduced. These might usefully be grown in school gardens, where the crop is at present unknown, to accustom the people to the sight of the crop. It would, however, be as well if, before introducing any new product of this kind, the schoolmaster would write to myself or the Deputy Director of the Division, and ask whether it is likely to be useful and how it should be cultivated. All such enquiries are welcomed, and every effort is made to ascertain the best information. Seeds will also be procured when desired and when it is thought that the crop is likely to be worth trying.

"It would be useless to attempt to lay down any rules for the size or nature or detailed management of a school garden. In most cases the school is situated in dry, uncultivated land, and unless there is a well within a very short distance, all gardening proper must be limited to the rainy season. The first thing to

do is to plant a few ornamental shade trees, and in choosing these it is best to select one of the trees seen growing in the neighbourhood. If water is available, fruit trees may be tried, and here again the Agricultural Department will endeavour to give advice as to the most suitable, if consulted.

"The first requisite of a school garden is that it should be neat and well kept and, if possible, ornamental. For the reasons given above, these habits stand in much need of cultivation at the present time. It would have the further advantage that it would make the school, too often an ugly unattractive building, an ornament to the village, and an object-lesson to the villagers of what can be done at small cost to make their own homes more ornamental than they are at present. Next, if any of the local crops can be grown, that is to say, if there is enough space, and if water is available when the plants are such as are usually grown with irrigation, some simple experiments in different methods of planting, manuring, watering, and cultivating might be attempted, and seed selection taken up. Hints as to the kinds of experiments recommended by the Agricultural Department will be found in the *Agricultural Calendar*, and if none of these are suitable, the officers of the Department will be pleased to offer suggestions if they are addressed. I will make one suggestion here which is applicable to any and every place where plants are grown: our experience shows that the weakest point in the practice of the Indian *ryot* is his neglect of seed selection. By growing any of the common crops of the village for a number of years, and choosing a few of the best plants each year for seed, it is easy to show the children that much better crops can be secured.

"In the case of private schools, where the owner, as is sometimes the case, is a rich landowner of the village, a good piece of land can be secured, and really useful work done. I recently saw a school of this description where a capital crop of groundnuts had been grown in the school garden in a district where this crop was new, and as the garden was near the road, many of the passers-by must have seen the crop. It is necessary

that people should see and talk about a new thing for some time before they seriously think of growing it themselves. School gardens can thus do a useful work in showing new kinds of crops to the people. On the Coimbatore Agricultural College Farm we give every student a plot of his own to cultivate himself. In most cases this would probably not be possible in a school garden, but those children who show special interest in the garden might be given small plots of their own and allowed to have the produce for themselves. Much, however, as from the point of view of the Agricultural Department I should like to see every one of the 25,000 schools in this Presidency turned into a sort of experimental farm, nothing would be gained by expecting too much practical result from the actual work done in school gardens. The real value of school gardens to the Agricultural Department will lie in the influence which they should have on the minds of both the teachers and pupils. We all know that education is not the pouring of information into a receptive vessel, but the process of turning the mind to the light, and placing it in a position where it can teach itself. The great obstacle to agricultural progress lies in the low esteem in which the farmer's profession is held by the educated and wealthy classes. I need hardly remind you that compared with the actual cultivator, all of us who belong to the other classes may be regarded as little better than parasites, living on the wealth created by the labours of the *ryot*. In spite of this, the farmer's profession is not held in such esteem as it should be, considering its utility to the community, and the skill, foresight, and patience required for success in it. The schoolmaster who starts a garden will soon find that to grow plants is not such a simple matter as he supposed. If he is wise, he will seek the advice of the best cultivators. He will soon see that the cultivation of the land calls for the exercise of a good deal of intelligence, judgment, and knowledge of seasons, besides mere hard work. This knowledge cannot fail to increase his respect for the parents of his pupils. On the other hand, veneration for the teacher is still a strong characteristic of

Indians. If the children see that the teacher himself is keenly interested in gardening and agriculture, and is not above working in the garden himself, it will tend to raise their respect for manual labour and for the profession of agriculture, usually thought unworthy of the serious attention of an educated man. It will also help them to see that the work of the school has a direct bearing on their after-life. The schoolmaster himself will find that the garden brings him into closer touch with the people of the village, and it will help him to understand the problems which his pupils will have to face when they leave his school.

"The effect on the minds of the boys, however, of a well-managed garden is by far the strongest argument for encouraging school gardens in every possible way. One of the greatest difficulties which we have to contend against in the Agricultural Department in our efforts to find out something about the agriculture of the country and improve it, is the want of power of accurate observation on the part of our subordinates, and the intense conservatism of the *ryot*. The former have, in most cases, had an English education, but have never been taught to observe the common objects which they see round them every day of their lives. Many of our present men are comparatively useless, because they have not had the advantage of being trained during their school days to use their eyes and accurately observe what is going on around their homes. A school garden, where the boys were taught to watch the growth of the plants from day to day, and notice the different effects of different methods of cultivation, might be made into a really useful instrument for training the faculties of observation.

"For the improvement of Indian Agriculture, however, it is not sufficient to have good officials. We also need an improvement in our raw material, the *ryot* himself. The vast majority of the boys attending the rural schools will follow the profession of a cultivator when they leave the school. I want all you students of this College to keep this fact always before your minds when you are training Elementary school teachers, and

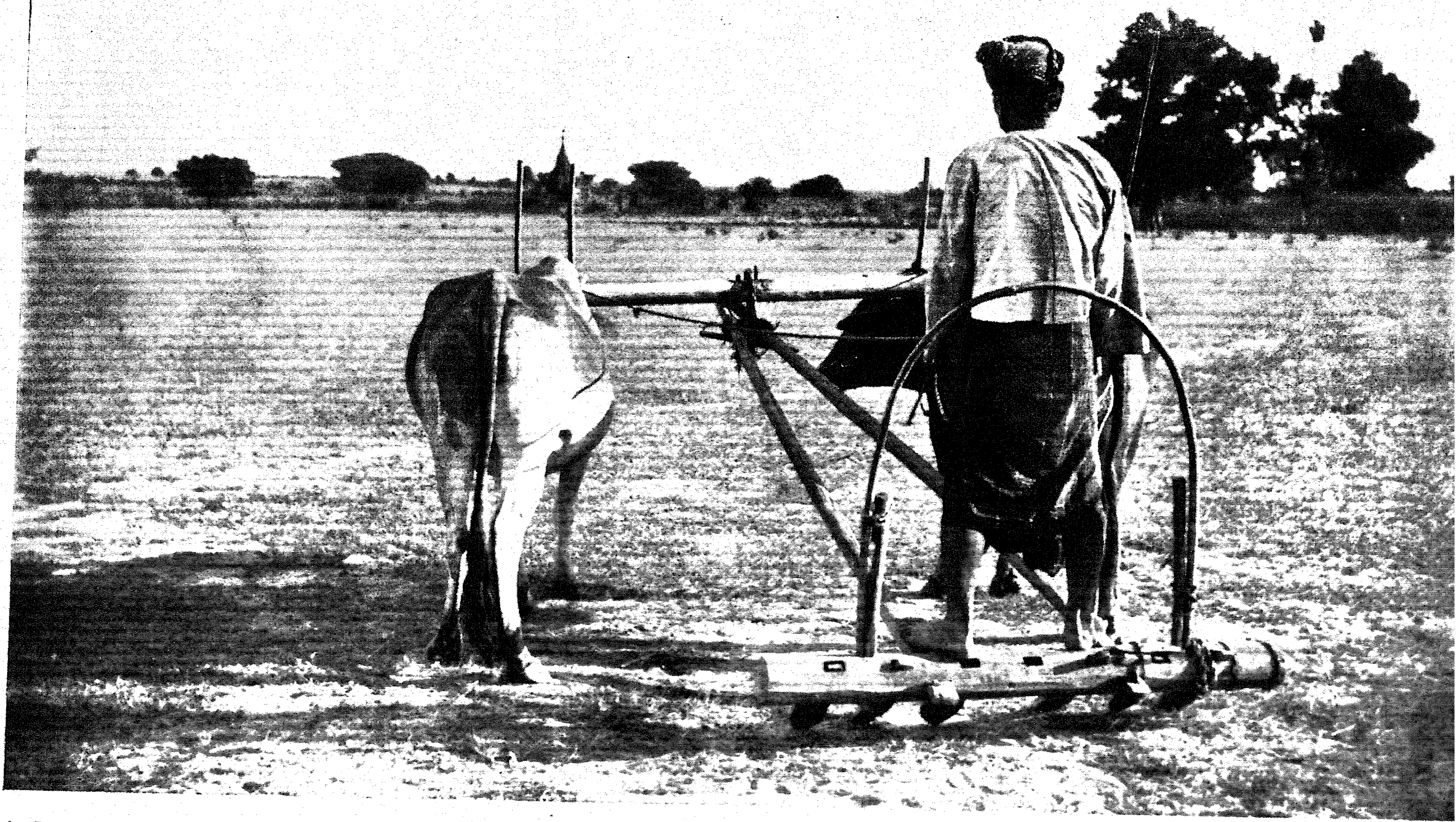
inspecting the schools. We want you to give us *ryots* whose minds are open to new ideas, and who do not, as the present generation of *ryot* usually does, condemn a thing off-hand, simply on the ground that they have not seen it before. The best way to do this is to influence all the public and private bodies who maintain the schools to have gardens at every school where space is available, and to see that the schoolmaster makes good use of it, bearing in mind the hint contained in the Madras Scheme of Studies that 'the instruction fails if it does not arouse in the child a lively interest in his surroundings.'"

ANDROPOGON SORGHUM: MILLET OR *PYAUNG*: ITS CULTIVATION AND SOME OF ITS ENEMIES.

By L. AUBERT, B.A., B.SC.,
Superintendent of Land Records, Burma.

In the dry zone of Upper Burma, where rice will not grow—the irrigated districts of Mandalay and Kyaukse excepted—in that part of the country with an average yearly rainfall varying from 20 to 25 inches, and which includes, roughly speaking, the southern half of the Lower Chindwin District, the Sagaing, the Shwebo, the Meiktila, the northern half of Yamethin, the Myingyan, the Magwe, the Minbu, the Pakokku districts, and the northern portion of Thayetmyo, the *pyaung* millet (*Andropogon sorghum*), known as *jowar* or *cholum* by the people of India, is the staple-food of the agriculturist and of his cattle. The former lives on the grain, the latter on the leaves and the stalks, dried and stored up as fodder for the dry season. *Pyaung* in this part of Upper Burma is to the people what rice is in the Lower Province, and sells at a figure that rice usually fetches in Rangoon. *Pyaung* is also grown spasmodically in other parts of Upper Burma, but only for sale or for export, and is not consumed by the grower as an article of food. A glance at the official statistics published by authority will show the importance of this crop both as a human food and as a cattle fodder. Within that part of the country above referred to as the "dry zone," the area sown with *pyaung* alone in 1907 covered 2,000 square miles, representing the main staple-food of a population of $2\frac{1}{4}$ million persons or 60 per cent. of the total population of Upper Burma; and the fodder of about a million head of plough cattle during four months of the dry season.

A. J. I.



Burmese Harrow or *htun*.

(Season and Crop Report and General Agricultural Statistics for Upper Burma, 1907-08).

Pyaung cultivation starts in September on upland *yas* or dry fields: these are termed dry by contrast with rice cultivation, which requires a great deal of moisture and water. Manure is not used generally unless the *ya* is a patch of jungle freshly cleared: in this case, all the useless timber or brush wood has been burnt on the spot, the ashes forming a fertilizer, during the months of May and June, before the break of the rains. *Pyaung* in such cases usually succeeds a first crop of early short-lived sesamum. The preliminary operation of preparing the soil for the seed is done in a peculiar and primitive fashion. The surface of the ground is scraped and broken up six or seven times lengthways and crossways, with a harrow, for a few mornings: a plough is not used. This is drawn by bullocks. A pair of ordinary bullocks can harrow or turn up in this manner about 12 acres in the season. Into a number of holes in the head piece of this harrow (in Burmese, *htun*) (Plate XVI) are inserted teeth, 8 or 10 inches long, made of a very hard wood, generally a form of *cutch* (*Acacia catechuoides*). The standard number of teeth used at the start is 3, if the ground is hard. It is increased during the following days to 5 or 7, the intervals between each tooth being reduced by degrees, as the clods of earth encountered at first are broken up in the course of the operation. These teeth do not penetrate to the depth a plough would do; but, for all purposes, the instrument seems suitable for this kind of cultivation: it has, at least, the great advantage of being easily repaired on the spot; it costs little, and the Burman will have no other.

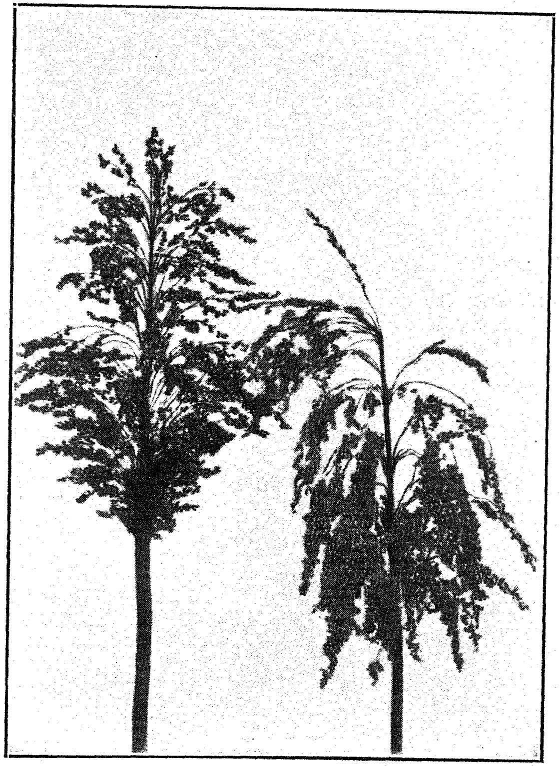
The ploughing and harrowing over, the cultivator sows his seed broadcast—from 20 to 40 lbs. to the acre. He then covers up the furrows by passing over them, once or twice, the *htundon* or head piece of the *htun*, from which all teeth have been previously removed. With favourable rain, the crop soon springs up; the average height of a fully matured crop is about 8 feet, and if all goes well, is ready to be harvested by the middle of January. An acre of land sown with *pyaung* returns, on the

average, 560 lbs. of grain, plus the dried stalks and leaves, which are stored up as fodder for the cultivator's plough cattle, when grass has become scarce. Several forms of *pyaung* are often grown at the same time by the same cultivator, but no difference whatever is made in the method of cultivation. The one most commonly grown is the ordinary *pyaung* with deep orange coloured panicles (*Andropogon sorghum* or *Sorghum vulgare*). Another common form with a fine golden grain, the *Shway-wa* (*Sorghum saccharatum*) found sometimes with reflexed panicles, is also called *Chinese sugarcane* or simply *sugarcane* (Bur. *kyan*) because of its sweet juicy stalks, resembling, with their nodes, the real sugarcane : the grain feeds the people, while the stalks form an excellent fodder much relished by the cattle ; but very often this name *kyan* is given to any form of *sorghum*. The reflexed panicle may also be found here and there on sorghums belonging to other forms. This reflexion of the panicle does not constitute a special variation or form of *pyaung*. Then comes the *pyaung kun-pyu* with a pale whitish hairy grain, also called *myet khongyi*, an inferior variation of *Sorghum vulgare*. A variety with a black seed, termed locally *pyaung net* or *nga cheik* (*Sorghum niger*) named also sometimes *pyaung hzee* by a few—is put down sometimes in small patches here and there. The cooked grain, said to be difficult to digest, is more starchy and more sticky than the other kinds, and is used mostly for making cakes and other dainties. Another *pyaung*, with a milky white grain, *Sorghum halepense*, the *hsanbyaung*, is also grown in certain localities. The grain when boiled approaches cooked rice in colour and in taste, and, for this reason, has been named *hsan-byaung*, "rice-*pyaung*." It is consumed by the more wealthy classes. The stalks, being hard and ligneous, are not given to cattle ; the surplus stock, bought by local firms, is exported to Rangoon where it is ground into flour as a substitute for wheat.

Pyaung is a very precarious crop. The first cause of its ruin, followed always by disastrous results, is drought, or the failure of the season showers. In years of scanty or untimely rainfall, when the crop has failed totally, the cultivator of the

PLATE XVII

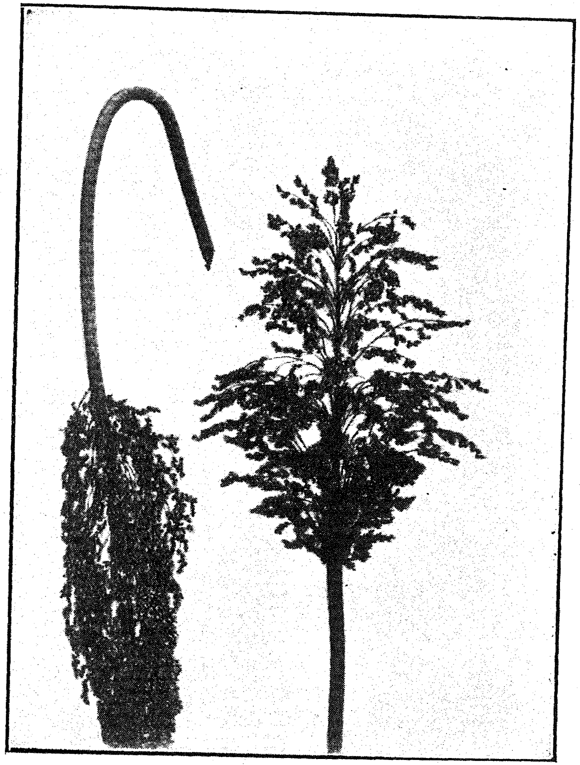
A



A. J. I. 1. 2.

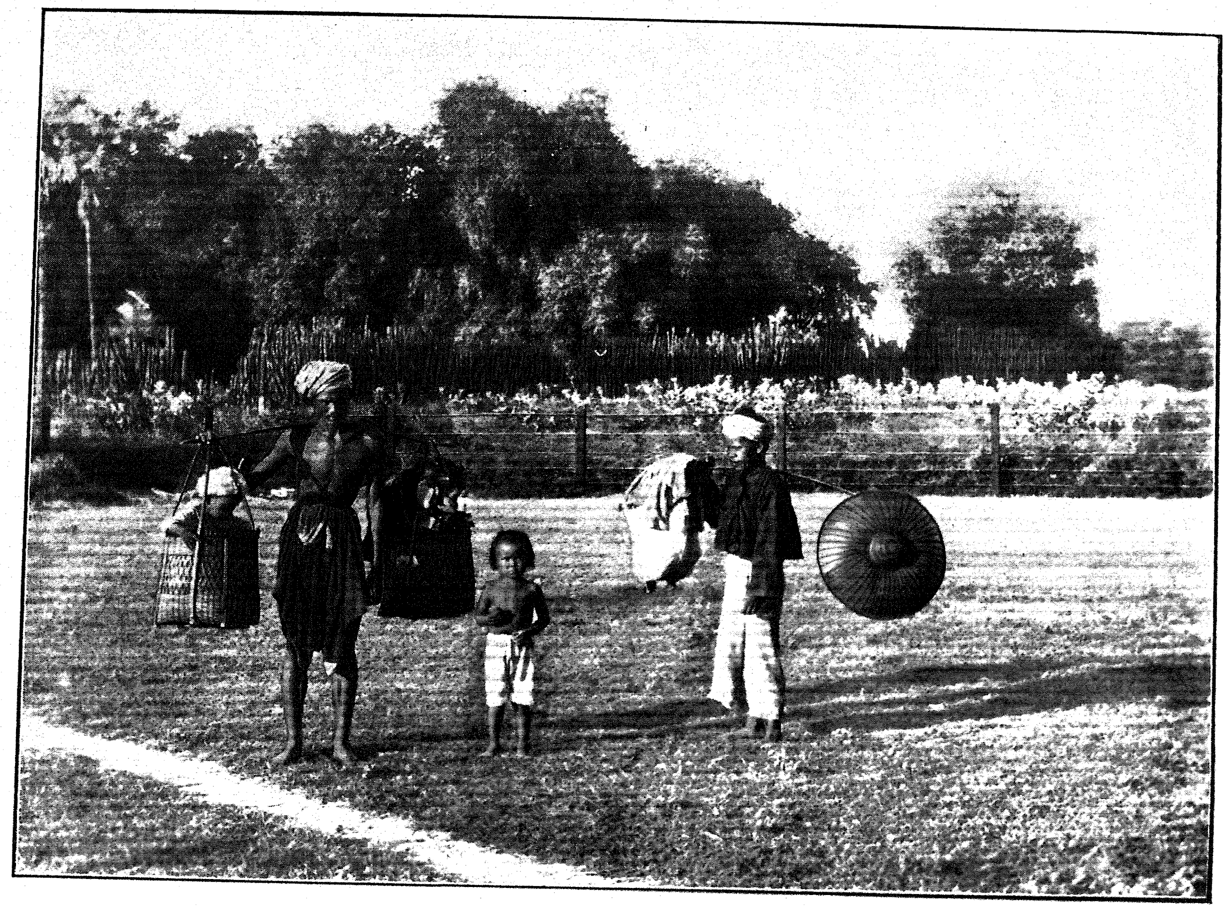
SORGHUM VULGARE (1) AND SORGHUM HALEPENSE (2).

B



1. 2.

SORGHUM SACCHARATUM.



A. J. I.

PALAUNGS TRAVELLING IN SEARCH OF WORK.

A. J. I.

Burmans en route to Lower Burma in search of work.

dry zone, who lives from hand to mouth, is compelled as a last resource to part with his best plough cattle, and to leave his village. He sells his cattle at the nearest town or cattle-market, packs his few belongings in a basket or two slung to a pole over his shoulder, and turns his face towards the lower districts in search of work. This emigration, when general throughout a certain tract, is the sure sign of a scarcity or of a famine. If the drought threatens to be a severe and prolonged one, necessitating an absence of several months, the whole family abandons the place, travelling on foot to the nearest lower district (Plates XVIII and XIX). Those who own a large number of cattle drive them down with them, selling them on the way.

Besides drought in years of scanty rainfall, and floods in years of excessive rain, like all other valuable crops, *pyaung* has a long list of enemies,—insects, fungi, and weeds. It is among the latter that the two most common, *Striga lutea* and *Convolvulus arvensis*, are found in Upper Burma. In fact, they can be discovered almost in every village at certain seasons, and their appearance in the fields causes awe and despair to the unfortunate cultivator.

Striga lutea, the *pwinbyu* (Plate XX) of the Burman agriculturist, an annual of the order of Scrophulariaceæ, makes its appearance at the end of August or early in September with the middle rains. This appearance among the grass in the *yas* or fields is signalled by its small white corolla of a peculiar shape, and from which it derives its name in Burmese of *pwinbyu*, the "white flower." At that time, or very soon after, the *pyaung* crop is sown on the uplands, and this *pwinbyu* grows with it. When the crop is about a month or two old, the weed has already managed to entangle and to entwine firmly its innumerable rootlets among those of its victim, and has begun stealthily its work of destruction underground and unseen. The young green shoots of the *pyaung*, healthy and promising a short time ago, begin to fade slowly; to wither and to die. The author of the mischief is not detected readily by an inexperienced eye. It is so small and shelters itself

always so well under the shady leaves of the *pyaung* plants, or among the grass and other undergrowth in the fields, that it is passed unnoticed at first. But if, with a little patience and care, one digs the earth deep enough around the affected plant, removing it entire,—not pulling and uprooting with a jerk, as the tender roots would thus be snapped off and left buried in the ground with the weed attached to them ;—if then, one takes up the whole plant with the clod of earth still adhering to it, and one stands it for a few hours in a pail of water, so that the earth attached to the rootlets is completely separated, the real enemy is at once revealed : this small and apparently harmless weed with its little white flower, quite unnoticed and unsuspected before,—the terrible *pwinbyu*. The scrofulous looking roots are found entangled with the tender smooth rootlets of the *pyanug* plant, adhering intimately to them in several places with tiny suckers through which the former tap the life and the sap of their doomed victim. This is found to be the case in years of drought especially, when entire fields are completely destroyed by the pest, which, by this means, supplements to its own benefit the deficiency in moisture and nutriment of the sub-soil below. In years of sufficient or fair rainfall, if a whole crop of *pyaung* is not entirely ruined, the outturn of it, at least, is considerably affected, both in the quality as well as in the quantity of the grain yielded.

The *pwinbyu* is said wrongly to have been unknown as a pest twenty-five years ago, before the annexation of Upper Burma, and I have heard old men, considered more or less as "wise men" in their own little villages, sadly remark that this was one of the many evils that had befallen the country, and the agriculturist class especially, since the fall of the pious King Thibaw, and his transportation out of Burma. The greatest hindrance to the improvement of agriculture in Upper Burma, and his brother villagers' very worst enemy by his conservatism and his apathy, is assuredly this type of wiseacre met in every small village.

One day when I had induced,—or rather believed I had induced,—some very obstinate and ignorant cultivators to try new

PLATE XX.

and more paying crops,—the groundnut for instance,—for which I had offered to obtain seed for them free, I overheard one of these village "wise men" who happened to be passing by, grumble sulkily, as if to himself, that "such seed issued free and so liberally could not possibly be good seed. With it germs of new pests and of new weeds would surely be introduced into the country. Had not the *pwinbyu* already been imported from the *kala* (foreign) country in a similar manner twenty-five years ago? But, besides destructive weeds and pests, increases in taxes and revenue rates would invariably follow in the near future." The next morning, the whole village came in a body to cancel their indents made cheerfully enough the evening before:

"*Timeo Danaos et dona ferentes!*"

The appearance of the *pwinbyu* in Upper Burma is certainly not as recent as the annexation, as certain cultivators and many others will have it. It is to be found in India, as well as in Burma, and is common throughout the eastern tropics (*Records of the Botanical Survey of India*, Volume III, No. 1 of 1904. *The Vegetation of the Minbu District in Upper Burma*, by A. T. Gage, Captain, I.M.S., page 85). The succession of several years of drought that unfortunately followed the annexation of Upper Burma has very likely made the ravages of this weed more noticeable and more felt than in good seasons and years of plenty. It is evident that in times of scanty rainfall, when the *pyaung* crop is weak and unhealthy, the *pwinbyu* must have a very destructive and fatal influence on the former, and must attach itself to the tender rootlets of the young plants in a more deadly grip than at other times, when rain is sufficient and there is abundance of moisture in the ground. Personal observations have confirmed this, and I am glad to be able to note that those same "wise men," mentioned above, after some discussion, have been forced later on to recognize and to admit this fact, which many of their neighbours, and, no doubt, they themselves, had stolidly observed without even making an effort to get at the true cause. A proof that the *pwinbyu* was well known in Upper Burma before the annexation is that a

large village in the Minbu district where *pyaung* was cultivated as a dry crop up to a few years ago, is called after the name of the weed. This village was founded some centuries ago, *pyaung* was extensively cultivated there and also on the uplands along the banks of the Môn River, before the opening of the new irrigation works by Government. Now rice, the favourite crop, has, of course, taken its place. Specimens of the weed were found there by me in 1901, and again by Captain Gage (now Major and Director of the Botanical Survey of India), and myself, in 1903, as late in the season as in the month of April (*Records of the Botanical Survey of India*, Volume III, No. 1 of 1904, quoted above).

At present, the Burman cultivator is helpless in his struggle with the weed, and is not even able to reduce or to circumvent its disastrous effects. No practicable remedy is known. Uprooting is not attended with success, and cannot be recommended, because, to uproot the weed thoroughly, one would have to dig up each *pyaung* plant with it, in order to disentangle carefully and sever all suckers from the former, returning the latter to its bed after such a difficult performance. For, if any fragment, however small, of the root of the weed is perchance left in the ground, or attached to the roots of its victim, the pest will spring up again in no time. Very often the *pyaung* plants are too far advanced to bear transplanting or any interference at all: they are in this case irretrievably doomed to succumb either under the operation, or under the attacks of their unrelenting enemy. It is therefore to be hoped earnestly that in the near future some remedy will be discovered, some chemical "germicide" or application, that will destroy this harmful pest, both in the plant or in the latent state of germs or seed in the ground, before the sowing of the *pyaung* crop can be attempted. This seems the only practical and effective means that can be suggested, one, at least, which would not be attended with disastrous or evil results on the growing crop.

The second enemy of the *pyaung* among weeds, not so dreaded as the *Pwinbyu*, but also very difficult to eradicate, is a

PLATE XXI.

A. J. I. CONVOLVULUS ARVENSIS (BURMESE *Kaukyo-nwè*).

small wild creeper or climber named by the Burman cultivators the *kaukyo-nwè* or *kukyo-nway*, the *Convolvulus arvensis* (Plate XXI). It appears annually in July or August, lasting till far into the dry season. Soon after its first appearance, it multiplies rapidly by shoots and layers, as well as from seed, spreading itself in all directions over a large area. By the time the young *pyaung* crop has attained a height of 2 or 3 feet, the weed is well established, and, without warning, in no time, it has entwined itself firmly along the stems of the tender plants, checking them in their growth. Constant weeding is necessary to keep it off. If the cultivator is at all slack or careless, his crop will soon be seriously endangered. This weed does not, like the *pwinbyu*, attack the roots of its victim, sapping its very life; it climbs up the erect stems of the *pyaung* plants as shown in (Plate XXI), retarding their growth and their development. Though not so deadly as the first one, it can cause considerable damage in a field, and is therefore quite worthy of being counted as one of the enemies of the *pyaung* cultivator.

The *kaukyo-nwè* does not, however, attack the rice plant. Its behaviour in a paddy-field is very different, no doubt on account of the excess of moisture always prevalent in rice cultivation. Here it keeps to the *kazins* or small bunds which always enclose rice fields to retain the water necessary to the crop. The cultivators make good use of the weed at harvest time, when it is collected in long strips to tie up the straw into bundles. Thence the name of *kaukyo-nwè*, or "creeper used to tie the straw," by which it is commonly known in Burma.

This short note has no pretension to be a complete and exhaustive review of the enemies of the *pyaung*. Myriads of birds, sparrows, crows, small owls even, attack the crop either in the flower or in the grain, by day and by night. It is also reported that a certain variety of snake, the *Russell's viper* (in Burmese *mway-bway*) is fond of the flower and also of the tender unripe grain on which it feeds. These snakes climb up the stem of the plant, and, by their weight, break and bend it

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to the ground, where they can feast at leisure. It is curious to note that the *Russell's viper* is very common in *pyaung* fields or *yas* at flowering time and until the crop has fully ripened.*

Pyaung is also attacked by a fungus disease, probably due to organic germs deposited into the flower by insects or by the wind. Many different kinds of insects too destroy the tender plants, but seem to have little or no action on the matured sorghums. In the early stages, however, they can do considerable damage to this most valuable crop.

Explanation of Plates.

Plate XVI.—A seven-toothed harrow: the middle tooth has been removed from the "*htundon*" to show the socket.

Plate XVIIA.—Panicles of *Sorghum vulgare* (1) and of *Sorghum halepense* (2).

Plate XVIIB.—Panicles of *Sorghum saccharatum* from the same field: 1, the reflexed panicle; 2, the erect panicle.

Plate XVIII.—*En route* for the lower districts.

Plate XIX.—A family of Palaungs from Pyawbwe (Yamethin district) travelling down to Pegu along the railway line.

Plate XX.—The dreaded *pwinbyu* (natural size).

Plate XXI.—The *kaukyo-nwè* entwined around a young *pyaung* plant (natural size).

* This fact was brought to my notice for the first time in 1899 by the *thugyi* or headman of the village of Aukkyaung, in the Minbu district.

MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.

By J. MacKENNA, M.A., I.C.S.,
Director of Agriculture, Burma;

AND

A. McKERRAL, M.A., B.SC.,
Deputy Director of Agriculture, Burma.

Mr. Standen's interesting note on this subject in Vol. III, Part 4, of the *Agricultural Journal of India*, has not elicited that amount of criticism which we had anticipated, and we wish to add our contribution lest we be barred by limitation or by an order from the Editor that "this correspondence must cease." Our contribution would not have been so belated had others kept the ball a-rolling.

The proposition laid down in Mr. Standen's article is to the effect that the value of the produce on the non-experimental part of a farm should be sufficient to make up, in part at least, for expenditure on the experimental areas, on buildings, supervising staff, etc.

The first question that suggests itself is: Why have a large non-experimental area at all? In the case of Burma we were advised to have large farms of about 400 acres each. Two such farms were taken up: one at Mandalay and the other at Hmawbi. In the case of a Central or College Farm a fairly large area may be advisable: but at our present stage of agricultural advancement, Government farms each of large area are certainly not at present advisable in Burma, because they suggest the full grown man rather than the creeping child. They may ultimately be required for testing on a large field scale the results of experiment, for the production and distribution of

selected seed of particular varieties of grain, fodder, and other commercial crops.

It must be borne in mind that experiment must necessarily precede such work. The logical sequence of events is first experiment, then demonstration, and finally seed production on a commercial scale.

A reason which may be given for the establishment of large farms is that they supply reserve areas to increase experiments which necessarily will extend in time.

The extent of the areas which may ultimately be required can only be tentatively guessed at for the time being, but an argument may be advanced for acquiring a large farm in each well-defined tract. It may be possible to work it profitably until part of it is required for experimental work. Mr. Standen states that the profits on a non-experimental area may only partially pay the way if worked departmentally. If it cannot be worked departmentally as economically as by an ordinary cultivator, it would seem preferable to sublet it to ordinary cultivators, till the land is particularly required by the department for demonstration, for seed-growing or for other purposes.

To summarise: the maximum area required ultimately for purely experimental work should be roughly calculated. This land should gradually be taken up for experiment as the necessity arises. At the first, the part not under experiment should be cropped uniformly, and outturns carefully noted so as to thoroughly determine the evenness of the soil.

Again, the work of demonstration and seed farms should be kept apart from that of experimental farms. They need not necessarily be in different localities, but may occupy contiguous areas The working and accounts should, however, be kept distinct.

There are other aspects of the question which probably do not strike the unsympathetic critic. An experimental station is really a field laboratory, and just as the processes in a Chemical Laboratory have to be cheapened down before they become a commercial possibility, so it is impossible to compare the expendi-

ture on an experimental station with that of ordinary commercial farming.

The ordinary farmer works with nothing but a profit in view ; the experimenter has the additional burden of investigating how that profit can best be increased. For this purpose exacting work is necessary, requiring an amount of supervision that is never thought of by the commercial worker.

If then the staff of an experimental farm are burdened with this exacting work, how is it possible for them to tackle, in addition, the extra work of commercial farm-work, in which, if they have not commercial success, they are apt to incur the friendly sarcasm of the ordinary cultivator ? Their work should end with investigation, the results of which, if favourable, should be imparted to cultivators on a *separate demonstration farm* and not in the midst of experimental work which they cannot understand, and from which they probably carry off erroneous impressions. It seems to us that this confusion of ideas between an experimental station and a model farm—corresponding to the difference between a laboratory and a museum—has been at the root of the whole of this discussion.

If it is necessary in the interests of an experimental station, or if, in pursuance of a policy, it has been deemed advisable to take up more land than is required for experimental purposes, then two means of disposal of the land, until it becomes necessary for experimental purposes, seem to us the only possible ones.

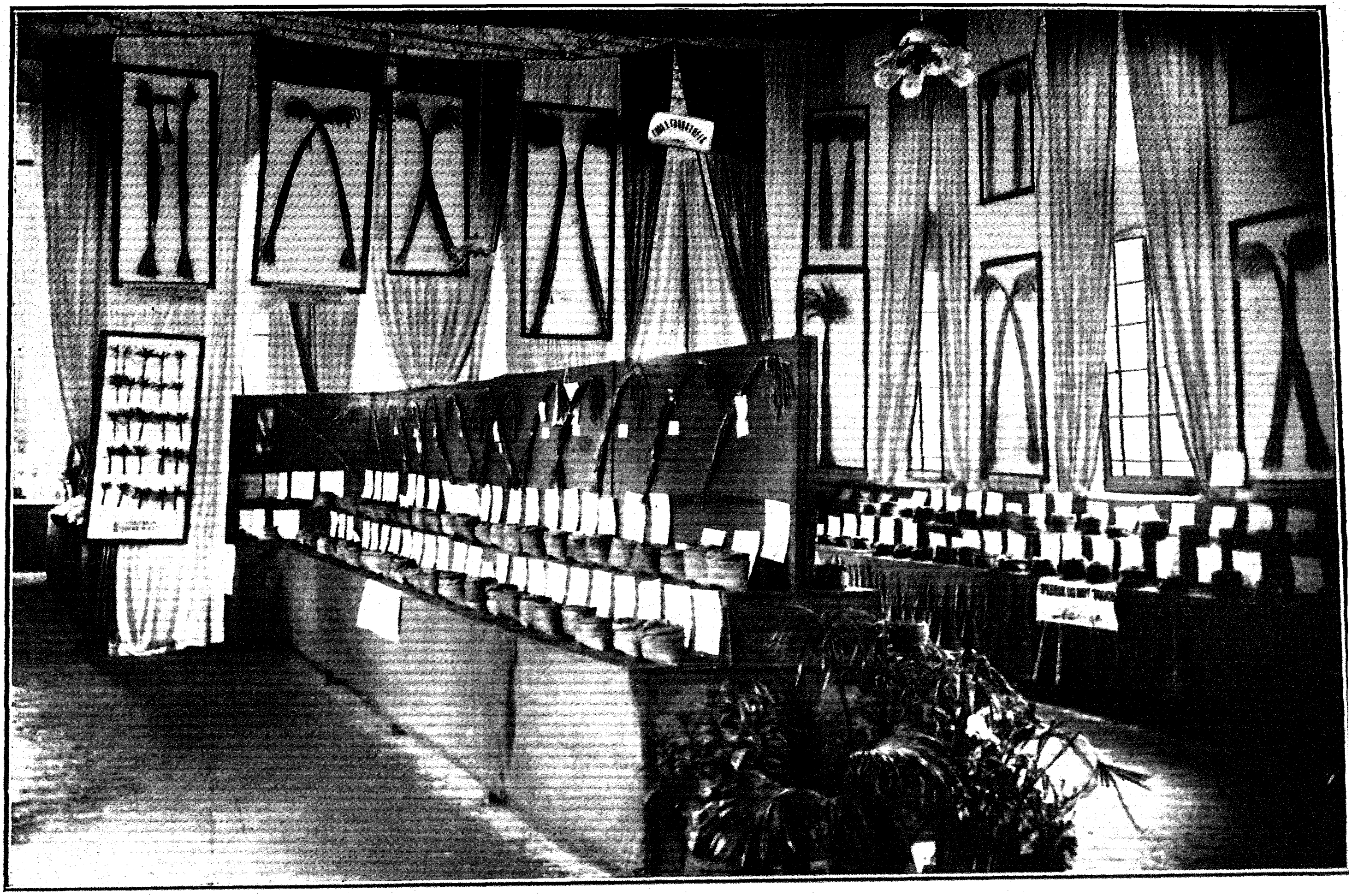
(1) It may be farmed by a staff which, while working under the Agricultural Department, will be chiefly concerned with the commercial aspect of the work. At slack times, the staff might be employed in extra work, such as preparing water channels, making or repairing fences, laying-out operations, etc. The books of this part of the farm should be kept quite separate and distinct from those of the experimental area, and a separate balance sheet should be made.

(2) The land might be sublet to cultivators on yearly lease and taken up by the Department as required.

Agricultural Departments have had to endure much criticism on account of the expenditure on their farms. But this is due chiefly to the jumbling together of experimental, demonstration, and ordinary non-experimental cultivation.

In conclusion, a word about buildings. We cannot compare the buildings required for a large experimental station with those required for the small holdings of *ryots*. The real comparison would be with a privately owned estate of similar size. Again, costly manure pits, silos, etc., are to devise methods, not to work commercially. Another factor which tends to excite remark as to cost and magnificence is the fact that Government buildings are erected by the State which can command capital at once; whereas a private land-owner would advance slowly and only as his bank balance grows. It is the sudden springing up of a complete and elaborate equipment that excites remark. Let us hope that in most cases, the equipment of our large experiment stations will look insignificant by the time that privately owned estates of similar size have equipped theirs, and that most of the ideas adopted by us may find a place in their scheme.

For small farms, however strictly limited to demonstration, there is no doubt that buildings of the simplest kind and on the lines of those ordinarily used by cultivators are the most effective.



A. J. I.

PUNJAB WHEATS AT THE LAHORE EXHIBITION.

AGRICULTURE AT THE LAHORE EXHIBITION.

By B. C. BURT, B.SC., F.C.S.,
Deputy Director of Agriculture, U. P.

THE Exhibition which was organised by the Indian National Congress with the support and co-operation of the Governments of the Punjab, North-West Frontier Provinces and Kashmir, opened on December 11th, 1909, and closed on the 6th of February 1910. Fairly full accounts have appeared in the daily papers, but a few notes on the Agricultural Section may be of interest to readers of the *Agricultural Journal of India.*

Unlike the agricultural court at the recent Nagpur Exhibition, this section at Lahore was not under departmental control, but was managed by a sub-committee ; the Agricultural Department, however, promised to secure and arrange exhibits. Little was done actually except by the department, and any success achieved was due solely to its efforts.

The agricultural exhibits were scattered, perhaps unavoidably, over the exhibition, but it will be convenient here to discuss them under certain main heads.

Crop exhibits were displayed in a large hall near the centre of the exhibition, and this section deserves praise for its arrangement and labelling. Exhibits were systematically shown in sections and groups, and clear labelling in English, Urdu, and Gurmukhi was welcome. Under wheats the most important exhibit was perhaps a set of 25 types of Punjab wheats, including mature plants mounted at full length, samples of grain, flour and bran and a chart indicating their relative value from a European miller's point of view as well as the nitrogen content of the grain—a readily ascertained figure which has proved such a useful guide in determining the probable milling value

of a wheat. A number of other samples of Punjab and other wheats completed the section, and the whole showed very clearly to the wheat grower the possibilities of improvement in wheat cultivation and the work that is being done in this direction by the Provincial Department. Other cereals such as rice, maize, barley, oats and millets were exhibited in the same way as wheat, complete plants being shown where possible,—a point of considerable importance in this country where all fodder is so valuable.

Oil-seeds were represented by samples of seeds, oils and oil-cakes, supplemented in some cases by herbarium specimens.

Under fibre the cotton exhibits attracted most attention. A set of herbarium specimens obtained during the partially completed botanical survey of the cottons of the province was shown, accompanied by specimens of seed cotton, seed and lint from the Punjab and various other provinces. Two show cases sent by the British Cotton Growing Association, illustrating the different stages in cotton manufacture, attracted considerable interest. For these cases the exhibition was indebted to Messrs. Dewhurst & Co., and Messrs. Horrocks, Miller & Co. Other fibres were represented by a collection of fibres lent by the Fibre Expert, Eastern Bengal and Assam, and by samples of the different fibres produced in the Punjab. In other sections of the Exhibition a number of samples of fibre from other parts of India including several Native States were also noticed, a permanent exhibit from Mysore deserving special mention.

Amongst minor crops a fairly representative collection of the leguminous crop of the Punjab and adjoining provinces was on view, and well-arranged exhibits of tea accompanied by an excellent set of photographs illustrating tea-growing and manufacture formed an interesting part of the exhibition.

In the entomological section the most striking exhibit was a working demonstration of mulberry silk reeling; mention should also be made of a number of show cases illustrating the life-history of some of the more important economic insects of the Punjab. The exhibit of bees in a glass apiary attracted

PLATE XXIII.

A. J. I. COLLECTION OF FIBRES AT THE LAHORE EXHIBITION.

great attention. Visitors had an excellent opportunity of familiarising themselves with modern methods. The Agricultural Department is satisfied that bee-keeping is a possible village industry in parts of the Punjab.

A number of cases illustrating plant diseases were lent by the Pusa Research Institute as well as the drawings and plates which accompanied the actual specimens in the show cases. Although it is still somewhat doubtful as to what impression the average cultivator would gain from such exhibits, there is no doubt that they mark a distinct advance in the attempt to induce him to pay attention to the real nature of these pests.

In the poultry house the principal exhibitors were the Lyallpur Agricultural Station (who exhibited stock obtained from the Pusa Research Institute) and the Kuar Sahib of Patiala. The exhibits included trios of Brahmas, White Orpingtons, Partridge and Silver Wyandottes, black Minorcas and pairs of Embden geese, Aylesbury ducks and Mammoth Bronze turkeys; these birds, of which the black Minorcas seem to be general favourites, attracted considerable attention throughout the exhibition, more especially from the English, Mahomedan and Parsee visitors. Some of the birds exhibited were given over by the Inspector-General of Agriculture to a local zemindar at the end of the exhibition with a view to start a poultry farm. The incubator house invariably attracted a crowd. Here incubators were shown at work throughout the exhibition, and the glass faced incubator, which enabled visitors to see the chicks actually emerging from the shell, was a constant source of interest, as was also the foster mother.

Before passing on to agricultural machinery and the demonstration ground, mention should be made of the model grain elevator constructed by Captain Osboral, R.E. The ever-growing difficulty in dealing with the immense Punjab wheat export has suggested to many people the desirability of introducing grain elevators of the type used in America. The model referred to, parts of which could be shown at work, enabled visitors to gain a very fair idea of this method of handling grain.

This exhibit was completed by a series of photographs illustrating the real American grain elevator.

The exhibits of agricultural machinery were perhaps perforce somewhat scattered. European agricultural engineers are usually represented in India by firms, whose chief interest is general engineering, and these exhibitors naturally prefer to show a mixed exhibit illustrating all their activities. There was, however, a fair number of exhibits of useful agricultural machinery and implements. In the engineering section, agricultural machinery was exhibited by Messrs. Burn & Co., Jessop & Co., and Octavius Steel & Co., of Calcutta, and by Messrs. Herman & Co., Karachi, their exhibits including water-lifts, bullock gears, chaff-cutters, rice hullers, ploughs, and a variety of other agricultural machinery.

In the agricultural section proper the principal exhibitors were Messrs. Volkart Bros., who exhibited (on behalf of Messrs. Wallace & Sons, of Glasgow), a variety of agricultural machinery recommended by the Punjab Department, more especially their "Rajah" reapers, winnowers, ploughs and chaff-cutters. The Empire Engineering Company, Cawnpore, exhibited chain-pumps, well-boring apparatus, and an oil-press. Messrs. Marshall, Sons & Co. (Gainsborough and Calcutta), exhibited a steam thrashing set, a new model reaper (especially designed for the Punjab), and a portable engine. Unfortunately most of these exhibits were not shown at work, and for that reason lost much of their interest. M. Sardar Ahmed showed an interesting collection of "Chambal" water-lifts, fodder-cutters, winnowing machines and hand-weeding tools, some of which were extremely ingenious, though hardly practical.

The chief feature of the departmental exhibit was the collection of indigenous implements shown in the large tent, which included exhibits from all over India, including about 70 types of Indian ploughs. A complete collection of hand tools was also shown.

Reference has already been made to the chain-pumps shown by Messrs. Gavin Jones and by the United Provinces Department of Agriculture; in addition the "Baldeo balti" and Butler *charsa-lift* deserve mention. The former is an improved form of an

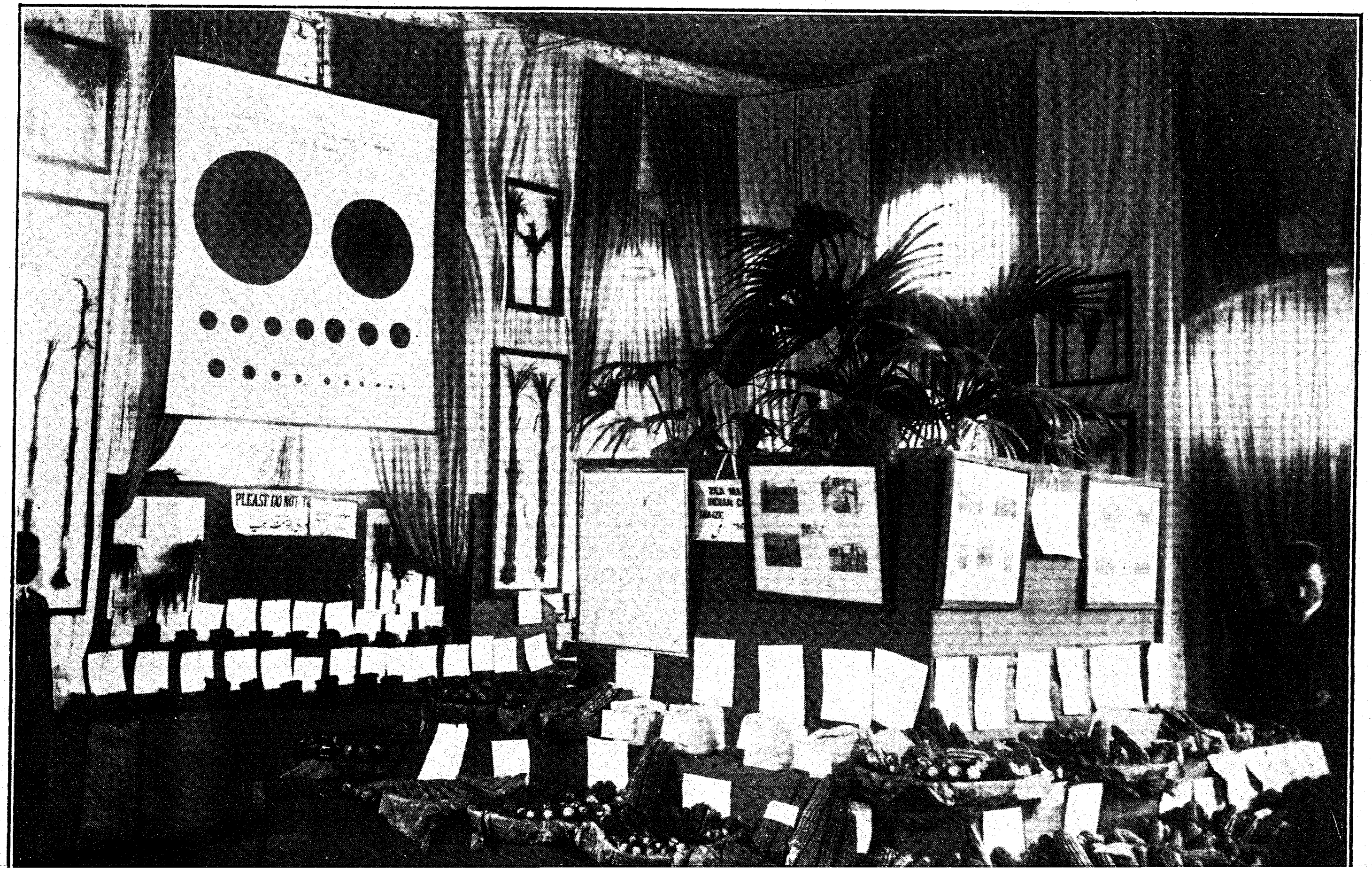
PLATE XXV.


THE INDIAN TEA CESS COMMITTEE'S TEA EXHIBIT
AGENTS THE INDIAN TEA SUPPLY CO LD CALCUTTA

illustrating different canal works which were unique and probably formed the most striking exhibit in the whole exhibition. Before entering the building one saw outside a series of models indicating the enormous increase in canal irrigation in the Punjab since 1865. The increase in capital invested by decade was shown by a series of golden pillars, the produce of irrigated land was graphically exhibited by a series of grain-bins ("*bhorras*") showing the expansion during each period, and the money value of the crop was indicated in an equal tangible form by columns of gold, another set of pillars indicating the revenue paid to Government. Having gained a preliminary idea of the enormous magnitude and value of irrigation works, the visitor passed into the building containing the exhibits of canal works; here were shown perfect models of a canal system from head-works to the small distributaries and cropped fields, together with models of some of the more important civil engineering works undertaken to carry the canal through difficult places, over hill torrents and under rivers. Of more direct interest to the agriculturists were the models showing the neat square fields and accurately aligned "guls" adopted in the newer canal colonies as compared to the irregular fields and winding distributaries of the older canal areas. The models were further supplemented by excellent photographs and by careful descriptions in both the vernacular and English. The whole exhibit showed the intimate connection which ought to exist between irrigation and agriculture in India.

In conclusion, the agricultural and other departments concerned are to be congratulated on having succeeded in arranging at such short notice such exceedingly interesting exhibits. They were handicapped in many ways so that criticism would be out of place; one felt regretfully, however, that given reasonable time for preparation the Punjab might have had a first class agricultural exhibition. It is, however, certain that useful work has been done in bringing the Punjab agriculturist in closer touch with that department which is charged with the development of agriculture.

PLATE XXVII.



JUTE IN ROTATION WITH PADDY IN THE SAME YEAR AND ITS EFFECT ON FOOD-CROPS.*

By B. C. BASU, M.R.A.C., M.R.A.S.,
Assistant Director of Agriculture, Eastern Bengal and Assam.

A Note was published by this Department in 1907-08 on jute in rotation with paddy in the same year and its effect on food-crops. It embodied the results of a preliminary enquiry as to the area under jute which bears winter rice or other crops in the same year. The enquiry arose out of a publication of the Bengal Agricultural Department, in which it was asserted with some degree of emphasis that if the jute crop were followed by winter rice in the same year, it would cease to interfere with the food-supply of the country, and the jute-winter rice rotation which had proved successful on the Burdwan and Cuttack farms was put forward more or less in the light of a discovery.

The preliminary note above mentioned was circulated among the District Officers and the Honorary Correspondents of the Department with a view to elicit further and more reliable information. The reports since received leave unaffected the main conclusion previously arrived at, namely, that the area under jute does represent the loss of so much land to rice, partly *aus* and partly winter rice. It is also clear from these reports that in all the important jute-growing districts, the taking of a crop of winter rice in immediate succession to jute was a well recognized practice, though various circumstances, some of which are unavoidable and others more or less preventible, stand in the way of this rotation being practised to its fullest possible extent.

The position in which jute stands in relation to the rice crop will be made clear by considering in some detail the system

* This was published in the *Indian Trade Journal*, Vol. XV, No. 194, Dec. 16th, 1909, p. 301.

of cropping that obtains in each of the four classes of land cropped with jute. Class I is high land which does not ordinarily retain water during the rains. Before jute assumed its present commercial importance, it used to be grown almost exclusively on this class of land. It admits of bearing two crops in the year, one in the rains which may be *aus* rice or jute, and another in the cold weather which may be mustard, pulses or a crop of vegetables. Any extension of jute on this land would mean the loss of so much area to *aus* rice.

Class II is lowland which retains a small depth of water during the rains, and is, therefore, suitable for growing transplanted winter rice. Under favourable conditions of soil and weather, it is capable of growing an antecedent crop of either *aus* rice or jute. In this case, however, the yield of the winter rice crop is more or less diminished, and not infrequently, when jute is the first crop, various circumstances (of which mention will be made hereafter) supervene to cause the winter rice crop to be omitted altogether. In the latter event the land may be utilised for a cold weather crop, such as mustard, pulses or vegetables. It will, therefore, be seen that on this class of land, too, jute is apt to compete with *aus* rice, as the first crop of the rotation, and to cause a serious diminution of the produce of the winter rice crop, partly by diminishing its yield as a consequence of the exhaustion of the soil, and partly because under certain conditions it prevents the winter rice crop being planted at all. In Sylhet and in the Assam Valley, the cultivators are afraid of risking the winter rice crop in favour of jute, and it is rarely seen on land ordinarily devoted to rice.

The third class consists of *beel* lands which remain under water for about six months of the year. It is the least important of the four classes of land on which jute is grown. The usual crop on this description of land is the long-stemmed winter rice which is sown broadcast in March to May and is reaped in December. The time that elapses between the removal of the rice crop and the commencement of the preparatory operations for the next year's crop is too short to admit of any

other crop being taken on this class of land in the same year. But on the margin of the *beels*, which does not go too early under water, it is a common practice to sow *aus* rice in mixture with the long-stemmed paddy, the *aus* crop being taken off early in the rains, and the winter crop remaining on the ground till December. It would appear that in many districts, jute has encroached upon this area and usurped the place formerly occupied by *aus* rice, and in some places it has ousted both the rice crops and is grown as the only crop during the year. The practice of growing jute mixed with winter rice obtains in the *beel* areas in Faridpur, Dacca and Pabna, but unlike the usual mixture of *aus* and *aman* rice, it has the disadvantage of crippling the growth of both the component crops. It appears, therefore, that when jute is grown on *beel* land, not only does it take away so much area that is fit for the growing of *aus* rice, but it also interferes with the growth of the winter rice crop with which it is sown mixed or ousts it altogether.

The fourth class is *char* land which is submerged during the rains and receives an annual deposit of silt which maintains its fertility more or less unimpaired. Unless where it is too low, it is capable of bearing two crops in the year, namely, one of *bhadoi* grain (principally *aus* rice) or jute in the rains and one of mustard, pulses or vegetables in the cold weather. Any portion of this class of land that may be sown with jute represents the sacrifice of so much potential *aus* land to jute.

The foregoing considerations make it clear that jute is a very serious competitor with *aus* rice on every class of land on which it is grown. It can be safely asserted that if jute were not a more profitable crop than *aus* rice, the high prices of food-grains which have prevailed for some years past would have caused the greater portion of the $2\frac{1}{4}$ million acres which now grow jute to revert to *aus* rice. Indeed, this process has already commenced and a considerable area which used to grow jute has gone back to *aus* rice. Then, as regards the winter rice crop the encroachment of jute on lowland (Classes II and III) has been seen to cause a reduction of the produce of that crop partly as a consequence of

the yield being diminished when it is grown with or preceded by jute and partly because of various circumstances attendant on jute cultivation, which often prevent winter rice being taken from the same land after it has borne a crop of jute.

It is almost needless to observe that the cultivation of transplanted winter rice as a second crop after jute is possible only in Class II of jute land, and none of the other three classes admits of this rotation at all.

Taking the province as a whole, about two-thirds of the total area under jute would appear to bear a second crop, and the remaining third grows jute as the only crop of the year. Among the various causes which tend to prevent the double cropping of jute land, the most important would seem to be the occurrence of unfavourable weather conditions interfering with the sowing or transplanting of the second crop, the demand which the retting and washing of the jute crop makes upon the labour of the cultivator, leaving him little time to attend to anything else, and the impoverishment of the soil caused by jute which makes it necessary to leave the land fallow for a season. Indolence and want of ambition not infrequently stand in the way of the double cropping of land. In the Assam Valley, waste land being abundant, the need of double cropping is not everywhere felt. The custom of letting cattle loose, as soon as the winter rice crop is off the ground, is also responsible in some places for the absence of cold weather crops.

There is no doubt that but for jute, a considerable area of cultivated land would be now lying uncultivated, and the practice of double cropping would be less common. It is also probable that jute has led to the manure supply of the country being more fully utilised than was formerly the case. The country has no doubt gained largely from these results as well as from the large profits which jute has brought into the pockets of the cultivators ; but at the same time there can be little doubt that as far as the supply of home-grown rice is concerned, the introduction of jute has had an effect which is otherwise than beneficial.

BLEACHING OF GINGER.

By G. B. PATWARDHAN, B.SC.,
Assistant Economic Botanist, Bombay.

During the course of my trip to Southern India in 1908, I had occasion to halt at two important centres of the ginger trade in Travancore territory. At these places there were a few large and many small ginger curing houses for converting green ginger into the dry form locally (Poona) known as "sunth."

There are several factories for bleaching ginger on the western coast of Malabar. The process in short consists in soaking, then washing the material (green ginger) in lime water, and then fumigating it with sulphur vapour.

Advantages of Curing.—The object is to increase the keeping quality and also to dry it without loss of shape. Green ginger on exposure for a few days either shrivels by drying and becomes stringy and mostly useless for our domestic medicinal use, or if buried in the ground sprouts up after a time and requires to be then properly cultivated. At the same time curing facilitates transport and sale. The time which ginger will keep, is thus increased to nearly three years.

The apparatus and articles required are :—

Green ginger.	Bleaching rooms with fittings.
Washing tanks.	Shallow trays made of wicker work.
Lime cisterns.	Sulphur powder.
	Cocoanut oil.

Bleaching Room.—This is $12' \times 12' \times 12'$, with three horizontal tiers of shelves arranged at a height of 3 feet from each other; these are usually made of split bamboos. The shelves support small shallow baskets of 9 inch diameter placed close to or upon each other. The room is provided with one door and at one end

with a hearth. The latter is a simple niche in the wall of the room (कोनाडा) opening from outside and situated close to the floor. The niche is two feet high and about as much wide, built in the thickness of the wall, with a portion projecting inside the room. The inner projection holds on it an iron basket which is consequently seen only in the room. The basket can be heated from below by igniting a fire in the niche outside. The sulphur which is placed in the basket, gets heated and fumes issue which fill the whole air space in the room. The basket gets the direct heat, and no smoke or heat escapes into the room from the hearth. The ceiling of the room is made of split bamboos and plastered with mud and tiled, making it more or less air-proof. The bleaching rooms in some establishments are often double the length given, with two hearths and one door.

Washing Tanks.—These are $6' \times 6' \times 6'$ built of masonry and lined with cement and hold the necessary quantity of water.

Lime Cisterns.—These are of the same dimensions as the washing tanks. One or two spare cisterns are often provided at each place of manufacture.

The Operation.—Vendors of green ginger come from different mofussil villages which are often situated in thick jungles. These people are actual individual cultivators of ginger and bring their produce for sale to the places of manufacture. The manufacturer purchases large quantities of it, and after bleaching it exports it to Bombay and Europe.

The green ginger on receipt is first put into the washing tank in water. Two or three men tread the material under foot. The adhering mud is washed off and becomes mixed with the water. During the treading the outer skin of the ginger is rubbed off. The water is removed and renewed according to necessity.

Next the cleaned and decorticated ginger is transferred to the lime cistern. This contains lime water of the consistency usually considered sufficient for white-washing walls. Here the ginger remains for some time, during which it is stirred once

or twice to effect equal soaking and permeation of lime into it. Afterwards the roots (rhizomes) are transferred to small shallow trays. These latter are made of wicker work and are 9 to 10 inches diameter. The trays are taken to the bleaching room and placed on the shelves mentioned above. One room of the standard dimensions holds 300 of these trays, a hundred going to each shelf and each basket taking 5 lbs. of green ginger. Seven pounds of powdered sulphur is put on the pan, and fire started from outside. The door is now closed and remains so for four hours. The ginger absorbs all the fumes produced by the vaporization of the sulphur in the pan. Afterwards the door is left open for a short time, and then the trays are taken out, and the ginger is spread out in the sun for drying. The fumigating operation is done again the next day and repeated a third time the day after, the material being dipped in lime water before every fumigation. Eight and nine pounds of sulphur are used for a second and third bleaching, and the exposure to the fumes inside the room is 12 and 6 hours respectively. The ginger is dried in the sun before each successive fumigation. Sometimes liming is neglected before the first fumigation, only cleaning and washing being done. But this is said to lower the quality of the article in the estimation of the purchasers.

Precautions.—The fumes of sulphur are poisonous and choke the breath of persons who inadvertently go into the room immediately after opening it. The doors are kept open for a few hours after the required interval of fumigation is over, in order to let out the remnant of the sulphur vapours into the atmosphere outside. Coolies get in afterwards to take out the baskets. These men smear their bodies with cocoanut oil to prevent injury to their skins (the only garment on the body of these men is a *langoti*, a strip of cloth tied at the waist), both by sulphur vapour and lime water spatterings.

The green ginger is purchased locally at the rate of Rs. 100 per *khandi* of 600 lbs. So 1,500 lbs. cost Rs. 250 and the cost of bleaching it is Rs. 11-4-0, at the rate of Rs. 4-8-0 per *khandi* (total Rs. 260-4-0).

The average yield of ginger per acre on this side is 8,000 to 10,000 lbs., and the cost of converting this into "sunth" would be about Rs. 60 to Rs. 70 at the above rate. Sulphur at Alleppey costs Rs. 40 to Rs. 45 per maund, and it will perhaps cost less here (Poona), as this place is closer to Bombay whence the supply is obtained.

CARAVONICA COTTON.

By G. A. GAMMIE, F.L.S.,
Imperial Cotton Specialist.

In the *Board of Trade Journal*, Vol. 66, No. 668 of the 16th September last, there is a short note on the experimental cultivation of Caravonica cotton in the Sudan. From this we learn that the agent of the Sudan at Cairo reports that it was decided to discontinue these experiments because the growth of the plants was not satisfactory, and the yield did not compare favourably with that from Egyptian cotton.

I have already dwelt on some experiences with this cotton in India (*Agricultural Journal of India*, Vol. III, Part 3, page 271).

In order to demonstrate further the slender grounds on which are based the assumptions claimed for Caravonica cotton, I shall shortly quote information gleaned from a perusal of articles contained in the *Indian Trade Journal* and *Tropical Agriculturist.*

From the former (September 30, 1909), we gather from reliable authority that, at the present time, there are several small growers of this cotton in the immediate vicinity of Cairns, one having some 10 acres planted out. There are three varieties, and the indications show that they are not constant in their characters, and that the young plants are liable to attacks from insects. The article, which should be read in full by those interested in the matter, is indefinite on vital points, but the short abstract I have given serves as a useful commentary to what now follows. In the supplement to the *Tropical Agriculturist*, Vol. 32, New Series, No. 2, page 186, a long note on an interview with Dr. Thomatis can be found. He again avers that he established his hybrid cotton in the short space of five years. He

attributed its failure in south India to unseasonable planting or unsuitable rainfall. In Queensland (he went on to say), where they have anything from 138 to 200 inches a year, the rainfall occurs during the four months, January to April, and the cropping conditions are excellent. He was only withheld from opening out land for his cotton on an enormous scale by the refusal of the Australian Government to allow the importation of some thousands of Indian coolies. In Lancashire his cotton is still considered to belong to a fancy kind and too fine for ordinary work. On the Continent, however, it has been widely taken up, the silky kind being used for making all the fine classes of cotton and the woolly as a substitute for wool. In Berlin are the headquarters of a syndicate, called the International Cotton Company, with a capital of £6 or £7,000,000. This will lend money at 3 per cent. and provide seed, and the only restriction is that no seed must be sold or disposed of outside the Company, although the grower can do as he chooses about the sale of his cotton. Dr. Thomatis is advising Director to this Company, and he is now selecting land in German East Africa. He says that, already some 750,000 acres are under preparation to grow it in the Sudan. (We know that this statement is not accurate.) Sixty or seventy Norwegian families have migrated to Eastern Cuba expressly to grow Caravonica cotton, and they sailed in the "Fram," Nansen's ship of Arctic fame! He unfortunately considers that perhaps Ceylon has not a climate quite suitable for Caravonica cotton. Caravonica is said to yield one ton (2,240 lbs.) to the acre, about 90 per cent. pure fibre being obtainable from a properly grown crop, against a minimum of 300 lbs. per acre with Egyptian.

In another issue of the *Tropical Agriculturist* we learn that a produce broker of Brisbane has evolved a hybrid "Mamara," which promises to be a serious rival to Caravonica. It has yielded at the rate of 300 lbs. of lint per acre, and a small crop is secured in six months after planting.

He who runs may read and form his own conclusions as to the merits or otherwise of Caravonica and other vaunted tree

cottons. It is strange that the marvellous results proclaimed on their behalf have never been attained within our experience in India. Even in Australia where we have cast our mind's eye over boundless plains whitened with the overflowing harvest of Caravonica cotton, the bald truth is published that there are several small growers of this cotton in the immediate vicinity of Cairns !

To go no further than India itself, we have several instances of men who, misled by paltry results obtained from carefully nursed plants in their own compounds, have persuaded complacent friends to waste their substance in attempting the hopeless task of tree cotton cultivation on a commercial scale.

The tree cotton which will succeed as a field crop has still to be discovered, and until it is really found and certified to be a success by responsible and disinterested men, the public in general will be well advised to withhold their financial support from well-meant, perhaps, but visionary schemes of amassing rapid fortunes from tree cotton cultivation.

THE CULTIVATION OF THE BANANA IN TRAVANCORE.

BY T. PONNAMBALLAM PILLAY,
Excise Commissioner, Travancore (Retired).

THE central and northern parts of Travancore have the advantage of two monsoons, and are, therefore, specially suitable for the cultivation of the banana.

As far as can be ascertained, the species grown is *Musa paradisiaca.*

A well-drained deep rich red soil is most suitable, but the crop also grows well in medium black soil. About a year before planting, the soil is ploughed frequently, and the ground is enclosed with mud walls or fences to protect the crop from cattle. The time for planting varies according to localities, but it is generally between December and February.

When the soil is well prepared, pits 3 feet deep and 3 feet round are dug 8 feet apart; an acre contains about 1,200 pits. To manure the pits, dried leaves are burnt within them, and the ashes are well mixed with loose soil to fill up $\frac{3}{4}$ths of their depth. This also protects the plant from white ants. The shoots are then planted in the pits and manured with fresh cow-dung. The pits are then filled with earth up to the level of the ground and covered over with dried leaves to protect them from the sun. The shoots are not watered, but occasional showers help them to strike root and grow. When they make a fair start, they are manured with cowdung (fresh more preferable) and green leaves.

Most of the plantations when established continue to produce fruit for ten or more years, provided the soil is regularly ploughed, weeded and manured. But yearly the old stems are

cut out, and fruit is obtained from the young selected shoots which grow about the parent plant. When the banana bunch is cut, those suckers which are not required and the stem which has produced fruit are removed to make room for the other stems which are intended subsequently to produce fruit.

Fibre can be extracted from the stems, and this industry is not neglected.

In Travancore, the skin or husk of the plantain is pealed off, and the pulp or core is cut into slices and dried in the sun. For infant food the slices are pounded into flour. The flour is nutritious. For adult food the slices are fried in oil or ghee with salt. The fried article is preserved for months in new earthen pots in a cool place. The fruit is also largely eaten by the poor, but it is not easily digestible.

An acre of bananas yields, on an average, about Rs. 200. But the cost of expenditure on the following items, when reasonably assigned, leaves no profit to the cultivator in the first year or years.

(1). The putting up of protective walls or fences around the ground.

(2). Ploúghing not less than eight times.

(3). Digging of 1,200 holes.

(4). Collection of dried leaves for burning in the pits as well as for covering them after planting.

(5). The cost of cowdung and green leaves.

(6). The cost of applying the same.

(7). Watching the garden.

(8). The collection of the crop.

(9). The collection and preservation of suckers and

(10). Rent for the land or interest on the capital.

The cultivator, however, derives profit by raising secondary crops such as yams, etc., which cost him almost nothing. The cost of weeding has only to be met. Between two plantain trees, three yam sets are planted. Some of the secondary crops are harvested before the bananas become ripe and some about the same time. This kind of cultivation does not exhaust the soil

as in the case of cassava, and the cultivator can also grow gram or peas without additional manuring. Before the cultivation of banana, the ground should lie fallow.

EXPERIMENTS ON THE AVAILABILITY OF NITROGEN IN PEAT, PEAT MOSS AND ELEPHANT DUNG AS COMPARED WITH CERTAIN OTHER MANURES.

By H. E. ANNETT, B.SC.,

Offg. Agricultural Chemist, United Provinces.

Samples of peat and peat moss were received from the Inspector-General of Agriculture in India, with a request for a report on their manurial value.

Analysis gave the following results :—

Peat	...	·59% nitrogen.
Peat moss	...	69% ,,

These analyses show that these substances, as far as their nitrogen content goes, are equal to the average Indian cattle manure. At the same time there is a widespread opinion that the nitrogen in peat and peat moss is in a much less available form than that in cattle manure. Accordingly it was suggested that I should test this point. Advantage was also taken at the same time of this opportunity of testing the value of a sample of elephant dung received from Indore State. An opinion has been expressed that this is much slower acting than cattle manure. An analysis of the sample showed it to contain 1·09% nitrogen. To investigate this question two series of pot cultures were started. The pot culture house at Pusa has been described in Vol. I, No. 3, Chemical Series, of the *Memoirs* of the Department of Agriculture in India. The jars and methods of filling them are also described in that memoir, and this description need not be repeated here. Only one kind of crop was tested, *viz.*, maize.

The first series consisted of 6 pots manured as follows :—

1. Un-manured.
2. Superphosphate + Cattle manure.
3. Ditto + Oil cake.
4. Ditto + Elephant dung.
5. Ditto + Peat moss.
6. Ditto + Peat.

No. 1 besides being unmanured bore no crop. The reason for this will be explained later.

The second series also consisted of 6 pots, but was manured as follows :—

1. Superphosphate only.
2. Ditto + Calcium Nitrate.
3. Ditto + Cattle manure.
4. Ditto + Oil cake.
5. Ditto + Peat moss.
6. Ditto + Peat.

The soil used above was Pusa soil—Indo-Gangetic alluvium. It is known to be sufficiently well supplied with potash, but it responds to phosphatic manuring, and hence superphosphate was supplied in each case. As about to be described, great care was taken in packing the soil to the same extent in each pot, the soil contained a constant amount of water, each pot contained the same number of plants, and every effort was made to make the various forms of nitrogenous manuring the only controlling factor. The soil itself contains a very low percentage of nitrogen—about ·03, but is highly calcareous.

The soil to be used was spread out and air dried and the amount of moisture remaining in it determined. Fourteen kilograms of soil were then weighed into each pot.

The manures to be used having been analyzed, such quantities of them were weighed out as would give an equal weight of nitrogen. The contents of each pot were now spread in turn on a clean floor and moistened with 1,000 c.c. of water. Any manure to be added was now carefully mixed up by hand with the soil and the soil carefully packed into its jar again. Nine seeds of maize were now sown in each pot. The maize sown was specially selected seed kindly supplied by Mr. Howard, the Imperial Economic Botanist. The young plants were visible in all the jars after five days. Each day each pot was weighed and

200 c.c. water added daily to each until 20% of water was present in the soil. The method of adding water is fully described in the memoir above referred to. After about eight days the requisite amount of water was present in each pot. Thenceforward the amount of water lost from the soil was determined daily by weighment, and this amount was added immediately. This was continued throughout the experiment. Thus, incidentally data were obtained of the amount of water given off from the soil during the growth of the crop. The object of the bare pot above mentioned was to determine the amount of the water evaporated from the surface of the soil. When the young plants were seen to be established, all except the four most uniform ones were removed.

When the crops were ripe they were cut close to the ground and the total produce weighed when air-dry. The straw, cobs and grain were separated, and the amount of dry matter and total nitrogen separately determined in each. Thus we have the necessary data to give—

(1) the total dry matter obtained ;

(2) the total nitrogen recovered in the crop.

Observations.

Series I was started just over a month earlier than Series II.

Series I.—Fifty-three days after sowing, the plants in the oil cake pot were far the biggest, and the next best plants were those manured with cattle manure and elephant dung. The plants in the peat and peat moss jars looked very inferior.

The plants were harvested 102 days after sowing.

Series II.—Thirty-four days after sowing, the smallest plants were those two, one of which received only superphosphate and the other peat moss. The healthiest and tallest plants were those on the pots receiving nitrate and oil cake.

On the whole, the plants of this series appeared much better than those of Series I.

The results of the experiments are set out in the table below :—

Laboratory No.	Manure.	Dry Matter in Crop.				Nitrogen supplied in Manure.	Nitrogen recovered.				Kilograms of water evaporated from soil and transpired by plant during growth.
		Grain.	Cob.	Straw.	Total.		Grain.	Cob.	Straw.	Total.	
	Series I.										
		gms.	gms.	gms.	gms.	gms.	gms.	gms.	gms.	gms.	
82	Superphosphate + Cattle manure ...	11·46	6·25	66·45	84·66	1·74	·1787	·0356	·2745	·4888	24·70
83	Ditto + Castor cake ...	30·12	12·09	70·47	112·68	1·74	·4608	·0411	·2748	·7767	29·43
84	Ditto + Elephant dung ...	7·21	7·09	63·65	77·95	1·74	·1356	·0744	·3182	·5282	20·25
85	Ditto + Peat moss ...	27·69	9·84	53·42	90·95	1·74	·4070	·0443	·2404	·6917	23·49
86	Ditto + Peat	13·95	8·60	64·55	87·10	1·74	·2456	·0594	·2840	·5890	23·34
81	Bare pot	...	...	...	...	...	...	...	...	...	9·54
	Series II.										
87	Superphosphate only	12·12	6·85	43·4	62·37	...	·1709	·0411	·243	·4550	28·20
88	Ditto + Nitrate ...	11·42	23·49	98·2	133·11	1·2915	·2363	·1574	·501	·8947	45·92
89	Ditto + Cattle manure ...	2·94	7·21	54·3	64·45	1·2915	·0427	·0774	·329	·4495	32·53
90	Ditto + Castor cake ...	24·65	15·35	74·8	114·80	1·2915	·355	·0732	·374	·8022	42·26
91	Ditto + Peat moss ...	8·73	9·10	61·0	78·83	1·2915	·1115	·0651	·287	·4640	33·35
92	Ditto + Peat	4·75	9·60	80·45	94·80	1·2915	·0712	·0921	·346	·5093	35·68

A very good series of pot cultures to test the availability of nitrogenous manures are being carried out at the Rhode Island Agricultural Experiment Station.* Two amounts of nitrogen, the one fifty per cent. greater than the other, have been added each year to different groups of pots. In those experiments the larger application has not usually resulted in a larger crop but in a more nitrogenous one.

Turning to the above figures it will be seen that the pots in Series I received 33 per cent. more nitrogen as manure than those of Series II, and except in the case of the castor cake pot more nitrogen has been recovered in Series I than in Series II.

If we compare the percentage of nitrogen in the grain from the two series we find those grains from Series I receiving the higher amount of nitrogen are more nitrogenous than the grains in Series II. This is shewn in the following table :—

Series.	Pot No.	Manure.	Weight of Nitrogen in Manure.	Percentage of Nitrogen in grain.
I	82	Superphosphate + Cattle manure ...	1·74	1·56
II	89	Ditto ditto ...	1·2915	1·45
I	83	Ditto + Castor cake ...	1·74	1·53
II	90	Ditto ditto ...	1·2915	1·44
I	85	Ditto + Peat moss ...	1·74	1·47
II	91	Ditto ditto ...	1·2915	1·28
I	86	Ditto + Peat ...	1·74	1·76
II	92	Ditto ditto ...	1·2915	1·50

The relative availability of the nitrogen in these various organic manures can be calculated as follows :—the amount of nitrogen recovered from pot No. 87, Series II, receiving superphosphate only, must be attributed solely to the soil nitrogen, as no nitrogen was applied in the manure. Subtracting this amount from the amounts of nitrogen recovered in the other pots, we find the amount of nitrogen recovered by the plants from the various nitrogenous manures. Thus the amount of nitrogen in the crop obtained from pot 87 was ·455 grm. The

* Rhode Island Agricultural Experiment Station—Annual Report, 1908, pp. 226 *[illegible]*

amount of nitrogen in the crop on pot 88 was ·8947 grm. and therefore the gain due to the nitrogenous manuring was ·8947 – ·4550 = ·4397 grm. From this figure we can calculate the proportion of supplied nitrogen recovered in the crop, and hence the relative availability of nitrogen in the various manures. The following table gives the data obtained :—

Pot No.	Manure.	Grms. Nitrogen supplied.	Grms. Nitrogen in the crop.	Increase in grms. Nitrogen over pot receiving no Nitrogen.	Per cent. of Nitrogen recovered.	Relative availability $NaNO_3$=100.
87	Superphosphate only ...	...	·455	......	......	......
88	Ditto. + Nitrate ...	1·2915	·8947	·4397	34·0	100
89	Ditto. + Cattle manure	1·2915	·4495	—·0055	—0·43	—1·26
90	Ditto. + Castor cake ...	1·2915	·8022	·3472	26·9	79·1
91	Ditto. + Peat moss ..	1·2915	·464	·009	0·69	2·03
92	Ditto. + Peat ...	1·2915	·5093	·0543	4·20	12·35
84	Ditto. + Elephant dung	1·74	·5282	·0732	4·21	12·38

Only the figures for Series II are shewn here, since all the plants of Series I had received nitrogenous manuring, and thus the percentage of nitrogen recovered of that applied could not be worked out.

The above table shows the high availability of the nitrogen present in castor cake, and also that the nitrogen in elephant dung and peat is much less available. The nitrogen of peat moss and cattle manure shows a very low availability in these experiments—the cattle manure giving an abnormal result—but of course very definite conclusions cannot be drawn from one set of experiments.

Wagner by Pot experiments in Germany, in the first year recovered 58·1 per cent. of the nitrogen applied in $NaNO_3$ and of dung 11·1 per cent. However, in his experiments the residues of the dung gave an appreciable effect even in the fourth year, while the nitrate of soda gave practically no effect after the second year.

Wagner's figures are rather higher than those obtained in the experiments recorded in this paper.

Our figure for the percentage of nitrogen recovered in nitrate of soda agrees fairly well with the figure obtained by Voorhees

and Lipman.* The only other manure used both by us and by them is farm-yard manure, and in this case, as seen, our farm-yard manure result is abnormal.

Conclusions.

1. Taking the total yield of dry matter, we find that of the organic manures, castor cake has given by far the best results.

2. From the yields of dry matter and from the percentage of nitrogen recovered, peat moss, peat, elephant dung and cattle manure appear to be about equally valuable as manures, though from the appearance of the growing plants peat and peat moss did not seem to be such good manures as cattle dung.

3. As regards the yield of grain, castor cake has given by far the best results, but the outturn of grain from the other pots are so variable that it is unsafe to draw any conclusion.

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* *J. Ind. and Eng. Chem.*, July 1909, p. 397.

URINE-EARTH AS A MANURE.

By D. CLOUSTON, M.A., B.SC.,
Deputy Director of Agriculture, Central Provinces.

Owing to the want of an adequate supply of manure, the cultivator in the Central Provinces is handicapped enormously. Much of his land is gradually becoming more and more impoverished. In tracts where there are irrigation facilities without manure, this exhaustion of the soil's fertility is all the more certain. It is a serious check, too, to the efforts being made to extend the cultivation of sugarcane and other profitable crops in such areas. The trade done in the Provinces in manures is insignificant, for the value of the different cakes as manures is not yet understood; moreover, the supply available is very small. To import artificial or other manures the *ryot* is not sufficiently enterprising. The result is that he is almost entirely dependent on the small supply of cattle manure at his disposal; but the so-called cattle manure in these Provinces is mostly the ash of cattle dung mixed with village rubbish. It is not a valuable manure, as its nitrogen content is low, 97 per cent. of it being lost in the process of burning. No attempt is made to conserve the urine which is so rich in this very essential plant food, and the one constituent which our black cotton soil stands so much in need of.

To meet this formidable obstacle to good cultivation, the dry-earth system of conserving urine is being demonstrated in these Provinces, and has already been adopted by some leading cultivators. With the view of testing the value of this manure I first started this system of conserving it on the experimental farms four years ago. The results obtained prove that in the year of application, the urine of a bullock for a certain period is

equal in manurial value to the dung of the same animal, for the same period.

The dry-earth system is a simple one which involves no initial expenditure and requires no other bedding than the dry-earth used. It is based nevertheless on sound scientific principles ; the earth absorbs the urine and retains its most valuable ingredients. The system, as carried out on the Government farms, is as follows. Dry earth to a depth of 6 inches is spread in the stalls. The dung is removed daily and stored in a pit. The urine-earth is removed from the stalls and stored in the same pit after having lain about a month in the stalls ; fresh earth is put into its place. By removing the dung daily the stalls are kept clean. Should the earth get caked, the surface is scarified by means of a *phowra* (scraper) in order to make it pervious to the liquid manure. By this method both the liquid and solid excreta are saved. The urine or liquid excrement contains a high percentage of the most valuable constituent, namely, nitrogen, and in a very soluble form too.

SOME ASPECTS OF AGRICULTURAL WORK IN THE CHENAB COLONY.

By G. F. de MONTMORENCY,
Settlement Officer, Lyallpur.

In the July number of the *Agricultural Journal of India* in 1908, an account was given of some agricultural conditions in the Chenab colony of the Punjab. In the present article, I propose to examine the agricultural conditions further, particularly in regard to how this great agricultural colony is supplied with work and milk cattle, from what tracts it obtains its supply, how far it can now meet its own needs, and what breeds find favour with the colonists.

In the previous article, it was explained that prior to the opening of the Chenab canal system, the area which now constitutes the colony was upland desert lying between the Ravi and Chenab riverains and divided up between the territorial limits of the Gujranwala, Jhang, Lahore and Montgomery districts. This tract was known as the Sandal Bar.

Before the colony was started, the chief characteristics of this tract were its extremely arid nature and the possibilities of fertility under irrigation.

The rainfall in the centre of the Bar, before irrigation was introduced, was about 5 inches annually.

The soil over the greater portion of the Bar is good loam, which merges into sandy soil toward the apex of the Bar near the meeting of the Ravi and Chenab rivers.

This land is, on the whole, quite level, but here and there, there are natural depressions where the soil consists of stiff dark clay.

Water flows into these lower lands from the surrounding higher land even after scanty showers, and this water remains for some time at or near the surface in spite of the fierce heat of the climate.

The Bar is covered here and there with vegetation, which is generally scanty, but is in places so thick that man or beast cannot easily force a way through it. The characteristics of the scrub growth provide an outlook of extreme monotony. In the cold weather or in the heat just before the rains, the *van* (*Salvadora oleoides*) with its grey green mistletoe leaf, the leafless thorny *karil* (*Capparis aphylla*), the *jand* (*Prosopis spicigera*) with its rough trunk and paucity of foliage afford a sad aspect of more or less lifeless vegetation, which only just holds its own against the rigour of the desert conditions. The winter frosts, the scorching summer heat and the rapid succession of dust-storms had their own special effects.

The Bar, without irrigation and without roads and the other advantages which have since been given, was hopeless for agriculture. It yielded up its secrets, however, to its own people, its aboriginal grazier nomads—the *janglies.*

The ground contained in its bosom the seeds and roots of many nourishing grasses and hardy fodder plants. During the spring and autumn and occasionally at other times after even the scantiest rain, the Bar bursts forth into verdure and freshness.

The grasses and shrubs in the best places of the Bar gave, after good seasons, useful grazing.

Round the lowlands, the *janglies* used to squat with their flocks and herds in temporary grass huts or under bushes. The heat or the cold of the Bar had no terrors for them, and the pathless jungle was to them a clear road to making a livelihood. These people lived on a very simple diet of natural desert foods with milk and milk products, varied very occasionally by meat and grain.

They owned herds of cattle, chiefly cows and young stock and some flocks of sheep and goats. Fairly good grazing

and constant change of pasture in good years helped to make their cows good milkers. The young female stock were usually reared with care, but the male stock were more or less starved from birth and were usually sold under two years of age to butchers. The *janglies*, these professional herdsmen of the Bar, made a good income out of *ghee*, skins and bones.

Except in years of particularly scanty rainfall, the *jangli* and his stock could live comfortably. In bad years, he lost a number of cattle and had to take refuge in the riverains. As a habitual custom, he increased his stock by thefts from the owners on the riverains. As an expert thief and tracker, he only lost cattle through thefts by his own people, and he retaliated speedily.

The two breeds of cows which the *jangli* kept were the Montgomery and the *kachi*. The Montgomery breed has been described in the *Agricultural Journal of India*, Vol. II, Part III, by Mr. L. French, I.C.S. The *kachi* is the Chenab riverain breed of cattle. These cattle are like the *Montgomery* breed in general characteristics, but are heavier.

In the old Bar days, the *janglies* numbered about 55,000 souls: and Lahore city was largely supplied with the *ghee* produced from the milk of their cattle.

Unfortunately, the grazing tax and cattle enumeration papers of the districts, in which parts of the Bar were situated, make no distinction between cattle owned by the *janglies* and cattle owned by the agriculturists of these districts, so we cannot even roughly compute the number of cattle which they possessed.

Into this land of Abraham with its flocks and herds came the Chenab canal. By the end of 1906 (the last special Chenab colony census), 1,829,880 acres of land were under cultivation by colonists, and the *janglies* had exchanged the shepherd's staff and the churning stick for the plough. The population had risen from 55,000 *janglies* to a mixed peasantry of 857,829 souls from every district in the Punjab. In all the villages of the colony, 20 per cent. of the area was reserved for grazing;

but owing to the lowest land being taken up for cultivation mostly, only the squares of poor quality and on high levels fell into the grazing reserve.

As the colonists came to the Bar, they each, as a rule, brought with them one or two yokes of plough cattle and a cow or buffalo for milk. Tenants also brought much the same. The village menials brought a few poor milch or plough-cattle and some sheep and goats. These animals belonged to the districts from which the colonists came. The population in the Chenab colony in 1906 was derived in the following proportion from the following districts:—

Gujranwala	9 per cent.
Gujrat	2 „
Gurdaspur	5 „
Lahore	3 „
Sialkot	9 „
Jullunder	8
Ferozpur	1 „
Amritsar	8 „
Hoshiarpur	5 „
Amballa...	2 „
Jhang	13 „
Ludhiana	3 „
Montgomery	10 „

The breeds of cattle introduced must have belonged to the breeds common in these districts. Gujrat would have supplied some *dhani* cattle; Jhang and Montgomery would have supplied the *kachi* and Montgomery breeds, and the other districts a large number of *desi* and *Hariana* cattle. The *dhani* cattle come from the Salt Range. They are almost invariably of white ground colour, heavily spotted with round spots of black or red.

The *Hariana* or Hissar cattle are very big sometimes and are easily recognised in the colony by their general handsome appearance and grey colour, and by being the most useful plough cattle for the Punjab. The *desi* is the common mongrel-breed commonly found in most parts of the Punjab. It is usually a small but very often a compact animal. The Montgomery cow is a good milker and gives usually rich milk. The Montgomery

bullock is slow. The *dhani*, *desi* and *Hariana* bullocks are generally more useful workers.

As the desert disappeared and the *janglies* got settled on arable holdings, they found they could not maintain their large herds and began to make considerable sales to the immigrant colonist of cows and young stock. The *jangli* finding he could grow plenty of green fodder on his holding, began to invest in buffaloes which gave more milk for the production of *ghee*. They were more profitable than his cows and were a welcome innovation for a milk diet. The immigrant colonists then added to their stock by purchase of cows and young stock of *kachi* and Montgomery breeds and by purchases of buffaloes from the Chenab and Ravi riverains.

In these early days, the average price of cattle was cheap. A *jangli* cow in full milk was worth from Rs. 25 to Rs. 45. A colonist's cow fetched Rs. 15 to Rs. 35; bullocks of different qualities, Rs. 25 to Rs. 90; female buffaloes, Rs. 40 to Rs. 70; male buffaloes, Rs. 15 to Rs. 25.

As conditions became more settled, the colonist became more wealthy and began to provide himself with better animals, both for draught and dairy purposes. His aim was to get good working cattle of the *Hariana*, *dhani* or *bhagnauri* breeds and really good milch buffaloes from Bahawalpur, Muzaffergarh and Multan or from the Sutlej or "*Nile*" breed. He made his purchases during visits to his old home or in the famous cattle fairs of Jalalabad, Amritsar, Hissar, Rohtak, Jaito (Nabha State) for *Hariana* bullocks, Chahr Saidan Shah (Jhelum district) for the *dhani* breed, and Dera Ghazi Khan, Karor (Mianwali), and Jellalabad (Sind) for the *bhagnauri* ox. He also made purchases from wandering dealers who discovered early that the Chenab canal colony was a veritable mine for cattle traders.

These traders are of two classes—(1) Aroras (Hindus) from the Western Punjab districts of Mianwali, Jhelum, Shahpur and Attock, who bring droves of *dhani* bullocks and cows through the Punjab towards Delhi for sale. Some dealers return with *Hariana* cattle from the Hissar, Karnal and Rohtak British

districts and the Nabha and Patiala Native States; these cattle are sold in the Chenab colony. (2) *Aroras* (Hindus) of Multan, Dera Ghazi Khan, Bahawalpur and Sind who bring *bhagnauri* bullocks and Sutlej buffaloes up to the colony and sell them to the colonists. These people usually arrive in the spring when the green wheat is on the ground and take their money in three instalments, one in each successive harvest. Wandering tribes and low castes, such as *Chungars*, *Meos*, *Ods* often hawk about inferior *desi* cattle and buffaloes which they sell to the village menials and tenants in the colony.

Fodder, particularly *bhusa*, is usually plentiful in the colony and the colonist does not stint himself in the matter of cattle and is always ready to pay a high price for a good bullock or buffalo. As a result, the price of cattle has now risen all over the Punjab. Zamindars in the colony now commonly give the following prices for stock :—

Bullocks	...	...	...	Rs. 60	to Rs. 220
Cows	...	...	...	„ 30	„ 125
Female Buffaloes	...	...	...	„ 90	„ 200
Male Buffaloes	...	...	...	„ 30	„ 50

Large *Gujar* communities have grown up round the colony towns, who supply their wants with milk. These professional graziers are buying up all the good Montgomery cows and have large herds of excellent buffaloes. They are experts in milk producing; but they sacrifice all the male young stock entirely to this object and even neglect the young female stock. They are content to get the last ounce of milk out of their cows and replace their cows by buying instead of breeding.

Lyallpur, the chief town in the colony, has curiously enough, in spite of the enormous import of cattle by colonists, become a very large export town for cattle. Once a year, a fair is held in the spring in Lyallpur. In 1910, 26,507 cattle were brought to the fair, of which 1,683 only came from outside districts; of these 8,940 were sold for Rs. 2,11,904. The cattle brought to the fair and sold are to some extent old cows, bullocks and buffaloes or young stock. The young stock is bought

partly *inter se* by the colonists and partly by zemindars of outside districts. The old stock is bought by (1) butchers and *Gujars* of the Rawalpindi, Attock, Abbottabad, Peshawar, Bannu and Kohat districts; (2) by zemindars of the Western Punjab. The butchers sell these animals either on the way to the frontier to zemindars or in the towns of their origin for meat for the Pathans and meat-eating Mahomedans of the frontier and frontier province. The zemindars buy the more useful wastrels for their own use. It is hard to pick up any good cattle, excepting young stock at the fair.

The Lyallpur district contains about $\frac{5}{8}$ths of the area of the Chenab colony. At the cattle enumeration of the district in 1909, the following stock was returned :—

Bulls and Bullocks	198,525
Cows	132,759
Male Buffaloes	37,759
Female Buffaloes	143,138
Young Stock of all kinds	213,030

That year the sown area of the district was 1,527,348 acres or 109,096 half squares (a square roughly is 28 acres). The half square here is the unit for which a tenant is employed, and for which a pair of bullocks is required. Adding together bullocks and male buffaloes, we have 236,373 animals. We want only 218,192 on the above calculation; but the surplus of 18,000 odd must contain many old useless animals, many entires and many animals only used for draught in towns and not available for the plough. The surplus over needs is therefore small. The existing young stock 213,030 and the stock which 132,759 cows and 143,138 buffaloes may throw, is, after exclusion of females and unfit produce and taking into account sales at the fair, not nearly enough for replacements.

The grazing area left, as before explained, is of poor quality. There are 53 district Board bulls in the Lyallpur district and every encouragement is given to breeding, and the Hissar bulls are undoubtedly leaving their stamp on the young stock of the district; but the colonist finds it very profitable to grow wheat, cotton and cane, and he restricts his fodder crops to the minimum

which will support his draught and milch cattle. He, therefore, keeps the buffalo which gives more milk than the cow, or more rarely the Montgomery cow. The Montgomery cow, even crossed with the Hissar bull, gives an inferior bullock. The colonist will not keep a large herd of poor milking *kachi*, *dhani*, *desi* and *Hariana* cows, which would give him excellent bullocks, but would not give him much milk. The rich colony, therefore, with all its local cattle and breeds and with its large export of stock must continue to buy mostly its best draught cattle from outside, while the Montgomery cow, the best Punjab milker, is getting fewer in number day by day owing to being milked to extinction by the *Gujar* and crossed with bad milking breeds by the colonists. We have wandered a long way from the *jangli* Abraham with his great herds of cows grazing in the upland deserts of the Sandal Bar. His place is now taken by the rich colonist with his expensive imported stall-fed bullocks and his imported stall-fed buffaloes.

NOTES.

Eri Silk Grown in Coorg.—This note describes the rearing of eri silk, which I have twice done with an interval of some ten years. The eggs arrived on the 26th July and hatched on the 30th. The first moult began on August 5th ; the worms were not fed or handled at this time. The moulting occupied two days and was complete on the 7th August. On the 9th the second moult commenced, and by the 12th some of the larger worms had moulted a third time, and many others had stopped feeding. On the 15th, the fourth moult commenced ; the worms fed greedily up to the night before, but on this date nearly all of them were inactive, and their skins presented a shrivelled appearance. On the 16th most moulted and changed colour from white to pale green. By the 17th all had moulted except a few and were feeding greedily. On the 19th they were larger, and were turning from yellow to pale blue. The mean temperature at this time was about 70 degrees, 60 at night and 75 at the maximum by day. On the 20th some showed signs of spinning and were transferred, some to paper cases, some turned loose in dry straw. When a worm is about to spin, it may be known by its uniform yellowish semi-transparent colour and by its being restless, ceasing to feed and moving about, waving its head with a circular motion. On the 22nd nearly all had spun.

The notes above refer to the second trial, made with seed from Ceylon, but the first trial was made with seed from Bengal ; the worm feeds on castor, and I thought of the castor as a catch crop, with a view to utilising the seed on some of the rubber clearings. The youngest leaves were used for the first few days,

and gradually tougher and older leaves were supplied as the worms grew older. The worms should be fed about four times a day and twice at night. They were kept in bamboo trays on shelves, the leaves evenly spread over the worms, except when they were moulting. The trays were cleaned out daily, the method being to spread large leaves over the worms which very soon moved up on to these, when they were lifted off to clean trays. The room was well-aired, and precautions were taken against rats which are particularly destructive when the worms are approaching the spinning stage. These worms thrive best in the monsoon and, unlike the mulberry silkworms, are unaffected by damp. The rainfall here is about 60 inches per annum, the greater part of which falls in the months of June, July, August and September, and it was found that the silk-worms grew fastest in those months, and that it was advisable after January and until April, to merely keep a stock for propagation. The elevation is about 3,000 feet. Where the castor plant was readily available, the cost of production was found to be from twelve annas to one rupee per 1,000 cocoons, this number weighing one pound.*

On the first attempt with Bengal seed, I found that by selecting the finest cocoons for seed, in one season the weight was almost doubled. The worms are very hardy and suitable for propagation under primitive conditions. They do not grow well in the cold season but like a moist warmth.

The chief difficulty in placing this variety of silk in the market appeared to be that special machinery would have to be introduced to treat it. I received some favourable reports on the silk from Manchester and London, and manufacturers were willing to set up the necessary machinery provided there was some guarantee that they would get regular shipments in large quantities. My reason for giving up the culture was on account of the want of an easily available market. It appears to me to be a culture eminently suited to villagers, whose wives and children

* This figure is very high; large broods can be reared at less than half this.—(EDITOR.)

have time to spend on the light work of feeding and tending these worms—(R. D. TIPPING).

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A METHOD OF SEED-TESTING IN USE AMONG THE CULTIVATORS OF THE BROACH DISTRICT, BOMBAY.—The cultivators of Gujarat are renowned throughout India for their excellent methods of cultivation, and an additional evidence of this is afforded by the existence among many of them of a system of seed testing which recalls those in use under the most advanced agricultural conditions. This method is chiefly used for wheat seed, but is applied to other seeds as necessary. It is known as the '*potli system*,' so-called from the '*potli*' or small sample which is used in the method.

In order to apply the method, a small sample of the seed is taken, placed in a cotton bag, and the whole dipped in water for twenty-four hours. It is then buried in a hole in the ground at the back of the cultivator's house for a further period of two complete days,—and then the number of seeds which have germinated is counted, and so the percentage of germination obtained. A sample showing more than from five to seven ungerminated seeds per hundred would be rejected, or the seed rate correspondingly increased.

The method is principally used for crops in which the cost of seed per acre is very high, as in the case of wheat. It is sometimes employed for *jowar*, but never for cotton, where heavy seeding followed by vigorous thinning is relied upon to secure the necessary stand—(G. D. MEHTA).

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FOREIGN FRUITS IN BANGALORE.—In some parts of Madras, fruit trees are grown by seedsmen without particular care. In and about Bangalore there are a few small orchards where apples, pomegranates, guavas, etc., are grown. None exceeds 3 acres in extent. Grapes are grown in a few gardens. There is a vineyard in the Palace Gardens of the Maharaja of Mysore.

There is a good demand for fruits in Bangalore. Grapes from Kabul and apples from Australia are readily sold at high prices.

There is room for considerable improvement in fruit culture in Madras and especially in Bangalore. The climate of Bangalore is suitable for growing both local and foreign varieties of fruits. In November 1906 a small orchard was started by Mr. M. J. Paul of Mildura (Australia) to grow foreign fruits, such as Australian navel oranges. This orchard has now been extended and is owned by the Mysore Fruit Syndicate, Limited.

The area of the orchard is 35 acres, of which 30 acres have been planted out. It is laid out on Australian models, having blocks of grape-vines surrounded by oranges, apples, apricots, peaches, etc. The methods of cultivation are those followed in California and Australia.

The following fruit trees are now grown in the orchard :—

I. *Grape vines* ... 9,000 in number, chief varieties being Muscat of Alexandria, Black Hamburg, Black Prince, Lady's Finger, Muscatel, Gardo Blanco, Sultanina (Thompson's Seedless), etc.

II. *Apples* ... Chief varieties—Ben Davis, Rome Beauty, Cleopatra, Jonathan Rokewood, Dun's Seedling, etc.

III. *Peaches* ... Chief varieties—Foster, Lovell, Elberta, Mountain Rose, etc.

IV. *Apricots* ... Chief varieties—Royal, Moorpark, Onlin's Early Improved, etc.

V. *Plums* ... Chief varieties—Greengage, Sugar plum, Japanese, Cor's Golden Drop, etc.

VI. *Pears* ... Varieties—Bartlett, Williams, Howell, and Duchess.

VII. *Figs* ... Two varieties—White Adriatic and White Genova.

VIII. *Cherries* ... Two varieties—Florence and Early Orleans.

IX. *Oranges* ... Two varieties—Australian Navel and Washington Navel.

The Navel orange tree fruits within one year from the bud. The fruit is seedless, especially the Australian variety, large, solid, juicy and flavoured ; some are as large as a medium sized pumelo. They keep well in long journeys.

The average yield of a grape vine is about 10lbs. of fruit, about the 4th year and onwards, and sells at annas 4 a lb. Each plant, therefore, yields fruit worth Rs. 2-8-0. The income from an acre of about 480 vines is, therefore, nearly Rs. 1,000, which is sufficiently remunerative.

The orchard is managed by Rao Bahadur A. Maigandadeva Moodaliar, the Chairman of the Syndicate, which is helped liberally by His Highness the Maharaja of Mysore. The Syndicate is also trying to cross local and foreign varieties—(T. V. SUBRAMANIUM).

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THE EFFECT OF PARTIAL STERILISATION OF SOIL ON THE PRODUCTION OF PLANT FOOD.—It has been known for a long time that if a soil be heated or treated with antiseptics so as to partially sterilise it, its productiveness is commonly increased. The cause or causes of this effect have been obscure, and a recent contribution* by Messrs. Russell and Hutchinson of the Rothamsted Experiment Station, on this subject, is exceedingly valuable, since it throws a good deal of light on the problem.

Briefly stated, if a soil be heated to 98°C. (208°F.), the succeeding crop will be two, three or even fourfold of what it would otherwise have been. The cause of this increased fertility has been attributed successively to chemical, to physiological and to biological changes ; and it has been the object of the Rothamsted work to provide a more correct explanation than that which has hitherto been offered. The first section of the new work showed that, whatever the actual cause, the effects of heating the soil to 95°C., or treating it with an antiseptic, such as toluene, were : (*i*) a much more rapid production of ammonia from the organic matter of the soil ; (*ii*) cessation of nitrification ;

* *Journal of Agricultural Science*, Vol. III, p. 111 *et seq.*

(*iii*) no marked change in the amount of humus in the soil; (*iv*) the production of unstable nitrogenous compounds was accelerated. It was also proved that an ordinary, that is, unsterilised soil, contained some factor which limits the development of bacteria, which factor is put out of action by partial sterilisation. Further investigation showed that the larger organisms, such as infusoria, amœbæ and ciliata, which are present in untreated soil, were practically absent from the same soil after partial sterilisation. These larger organisms are known to devour bacteria and consequently limit bacterial activity in a soil.

The explanation which Messrs. Russell and Hutchinson offer for the increased fertility of a partially sterilised soil is this. Soils contain a wide variety of organisms, which may be divided roughly into (*a*) saprophytes, which effect the decomposition of organic matter; and (*b*) phagocytes and other organisms which consume living bacteria, or are in other ways inimical to them.

When a soil is partially sterilised by toluene or heat, the phagocytes are killed, but bacterial spores survive. On removing the toluene and adding water these spores germinate, and the resulting organisms multiply with great rapidity, resulting in a largely increased production of ammonia. At the same time it was ascertained that some organisms suffer seriously, especially those which fix atmospheric nitrogen, and the nitrifying organisms are entirely destroyed. Thus, the nett result of partially sterilising the soil in the manner described, is to increase the amount of ammonia, but to inhibit nitrogen fixation and nitrification. The plant which is subsequently grown in such sterilised soil then apparently depends on ammonia as its source of nitrogen—(J. W. LEATHER).

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CULTIVATION OF SOY-BEANS IN INDIA.—Soy-bean should be grown as a *kharif* (rainy season) crop. The seed should be sown in June—July. The cultivation is similar to that of other pulses grown in India, *e.g.*, gram, which however, is grown in the cold weather. The crop is ripe in October—November

Superior varieties of this pulse have much more robust plants with broader leaves and larger pods and seeds and require more careful cultivation. Fairly fertile loamy soils and moderate rainfall are the most suitable. The land should be thoroughly ploughed and cleaned and should be in a good state of tilth before sowing. There should be sufficient moisture in the soil when the seed is sown. It is advisable either to drill the seed in rows, 12 to 15 inches apart, or to sow it by hand behind a plough, and then level the surface with a log of wood or otherwise. Care should be taken not to cover the seed below 2″ in depth at the most. It should be sown very sparingly at the rate of 15 to 20 lbs. per acre, and the seedlings should, if necessary, be thinned out, so as to leave a space of 9″ between them. The plants require ample room for their growth as they branch so freely that a mass of vegetation is produced which completely shades the ground.

After sowing, the only care required is to keep the land clean by hoeing and hand weeding, if necessary. The crop matures as soon as the leaves begin to fall, and then it should be harvested.

In a good year, the crop yields from 500 to 1,000 lbs. of grain per acre. In an experiment at the Poona farm in 1906-07 the average yield of different varieties introduced from Japan was 660 lbs. of grain per acre. The straw affords a very valuable fodder for all kinds of stock, who eat it most readily—(EDITOR).

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DRY FARMING IN THE TRANSVAAL—An article on this subject appears in the *Graphic* of March 1910, by Dr. William Macdonald of the Transvaal Department of Agriculture. Dr. Macdonald was deputed by his Government to visit the United States to report on the practicability of introducing into South Africa the American methods of "Dry Farming."

A Government "Dry-land Station" has since been established at Lichtenburg for experimenting in the conservation of soil moisture, tillage methods and drought-resistant crops. The station lies in the middle of the dry-land zone of the Transvaal in which it has always been thought that wheat could not be

grown. During the past season excellent crops of wheat and other cereals have been harvested. Dr. Macdonald is of the opinion that much of the arid land stretching from the Cape to the Victoria Falls—roughly 180,000,000 acres—having a rainfall from 10 to 25 inches per year, can be rendered culturable in a similar manner.

Another example is cited in the Demonstration Farm of Messrs. John Fowler, Ltd., Leeds, manufacturers of steam ploughing tackle. In this case with a poor soil and in spite of severe droughts excellent crops of maize have been produced.

These results have been obtained by means of thorough tillage; the ground is kept open by frequent ploughing, cultivating, harrowing and rolling. The soil quickly absorbs the rainfall, and afterwards evaporation is prevented by having a fine tilth on the soil surface. Steam cultivation lends itself particularly well to this class of work where large unbroken areas of fairly level land are found.

Dry farming is not, of course, a substitute for irrigation in semi-arid regions, it is only recommended where irrigation is impracticable—(G. H. HENDERSON).

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SEED SELECTION: (Extract from the *West Indian Bulletin.*)—Plants grown from seed vary to a greater or less extent from one another. If there is any variation in the first generation, each succeeding generation which is produced from parents with varying characters will become more and more varied, and this irregularity considerably reduces the value of the crop. It is necessary, therefore, in order to obtain a good uniform quality of cotton to adopt a system of seed selection in which certain individual plants, selected for their good qualities, are made the starting point each year.

The requirements of the spinner have to be considered, and every effort made to produce that class of cotton that he desires.

One point which the spinner strongly emphasizes is that the cotton must be uniform. A careful examination of cotton on the plants in the field show that although a large percentage of

the different plants are producing a fairly uniform quality, yet there are some that produce a better and others an inferior grade. When seeds are planted from an individual plant a little variation will usually be found. Many plants also show a certain amount of resistance to disease, have a great power to withstand adverse climatic conditions, are less liable to shedding of bolls and they may produce a larger yield of longer, finer and stronger cotton.

By carrying out these experiments varieties of plants especially suited to local conditions of soil and climate, will be obtained. Instead of producing a crop with different characters, there will be each year a tendency for the quality of the lint to become more and more uniform. The proportion of weak fibre will be reduced, the length of staple and the proportion of lint to seed improved and the general productiveness of the plant increased.

In the first place, by selecting the earliest ripened plants one would be able to produce (1) a plant which would occupy a shorter period between the sowing of the seed and the ripening of the crop, (2) by selecting seed from the plants which produce the longest staple, one would be able to develop plants producing still longer stapled cottons.

Similar results can be obtained by selecting the finest, silkiest, the most productive and the healthiest plants.

A simple method is to obtain seed from a place which realises the highest price and these seeds should be grown.

When the plants have come up, a field selection is first made; in this field the best plants are then picked out and a systematic examination made of each plant. The points on which plants should be selected are :—

(*a*) Habit.
(*b*) Height.
(*c*) Number of bolls.
(*d*) Maximum number of bolls per branch.
(*e*) Shape of bolls.
(*f*) Size of bolls.
(*g*) Distribution of bolls.
(*h*) Resistance of plant to disease.

In the field, the healthiest, most vigorous and best shaped plants should be selected. It is recommended that seed selection should not be commenced until the first bolls begin to open, for then the quality of the lint can be roughly determined. There is always a tendency for a large number of bolls to fall from the plants just as the first cotton is beginning to mature. Hence if seed selection is not commenced until some of the seed cotton is ripe, there will be a better chance of getting a more correct estimate of the prolificness of the plant. Again, when the cotton has begun to ripen, many of the older leaves are thrown off. The plants thus become to a certain extent bare and show up the most prolific ones much more readily. Plants selected in the field should be free from disease. A tall plant is not to be encouraged: these usually give a much lower proportion of seed cotton than plants of medium height, hence it is not advisable to select plants growing tall. The bolls should be of good size and as many as possible on the individual branches. The distribution of the bolls should also be general. In the field the seed cotton can be roughly examined. The fibre should be long. The selected plants should then be numbered and regular field notes be kept.

Cursory Examination—Before fixing upon any definite limit for any particular character, a number of samples should be examined to obtain an idea of the general quality of the product. This simplifies matters considerably and makes it possible to determine the best samples out of a large number. After the cursory examination the samples selected from the whole collection should be examined as regards the length. The characters for which the samples are examined are:

(1) The length of staple and uniformity of length.
(2) Weight of seed cotton per plant.
(3) Weight of seed cotton per boll.
(4) Proportion of weak fibre.
(5) Proportion of lint to seed.
(6) Proportion of lint per plant.
(7) Diameter of fibres.
(8) General appearance.

The weight of seed cotton per plant should then be determined.

The next character to be examined is the proportion of weak fibre, 30 per cent. being fixed as the maximum limit.

The proportion of lint to seed to be next determined, no definite limit to be fixed.

The general appearance is very important.

The weight of seed cotton per boll is an important feature, some might wish to develop a large boll; this will be much easier to pick the cotton from than a small one, and if each boll can be increased in size, it is very probable that the size of the general crop will be increased.

The size of the seed is also interesting. Large seeds are now generally recognised to produce more vigorous plants than small seeds. In cotton culture there is another feature to be taken into consideration, *viz.*, the proportion of lint to seed, and if the seed is materially reduced, the fibre producing area will also be reduced.

The diameter of the fibre is also important. The cotton with the slightest diameter is most suitable for spinning fine grades. Regularity in diameter of the fibres is also desirable.

The following methods have proved to be useful in determining various qualities :—

(1) *Length of Staple*—To determine this, a number of seeds should be selected from the sample of seed cotton, the number of the seeds depending on the size of the sample. When examining the seed cotton from the individual selected plants, it is convenient to take about ten seeds from different parts of the sample; the length of the lint on these is measured, the minimum and maximum noted and the average determined; reliable results are obtained by measuring the length of a few carefully arranged fibres.

(2) *Proportion of Lint to Seed*—It is convenient to remove the lint from the seed by means of a hand gin. To remove it by hand is very laborious.

After the separation has been made, the proportion of lint to seed is determined by weight.

It is questionable, however, if so very much importance ought to be attached to the proportion of lint to seed. The

variation is no doubt due to more than one cause, the most obvious being the varying quantity of the lint on the seed. Another factor might here be put forward, *viz.*, a larger weight of seed. The smaller proportion of lint in this case is only apparent. It is therefore desirable that the quantity of lint per plant should be considered as well as the quantity of lint on, say, 100 seeds.

(3) *The Proportion of Weak Fibres*—On each seed there are two sets of fibres, *viz.*, strong and weak. The weak fibres are arrested in development and possess walls which are extremely thin and transparent. The strength of the lint is practically determined by the proportion of these weak fibres present. The breaking strain of the two sets is as 3 : 1, and this fact is the one on which the principle of separation is based. After the process of ginning the strong and weak fibres are so mixed together that it is impossible to determine the proportion in which each is present, but while attached to the seed it is possible to separate them by drawing through them a weaver's fine steel comb. The teeth of this comb are fairly close together, and as they pass through the fibres, they offer a certain amount of resistance, and if carefully done, the resistance is sufficient to break the weak fibre from the seed, but not sufficient to break away the strong fibres.

The fibres attached to the seed are first carefully straightened out by means of the fingers; they are then combed out straight close to the seed. And then holding them at this point between forefinger and thumb, the loose ends are combed out straight. When the ends have been straightened, the comb can be drawn through their whole length, and the weak fibres will leave the seed, the strong ones remaining attached. The strong fibres can afterwards be detached from the seed and the proportion of strong and weak determined by weight. In order to obtain good results, it is best to work out a hundred seeds, and these should be taekn out from all parts of the sample.

(4) *Diameter of Fibres*—This must be ascertained microscopically by means of a graduated eye-piece. This work can be done very rapidly. It is not advisable to measure the weak fibres,

these being flat and consequently broader, and besides they constitute a factor which one must try to eliminate. Five mounts should be made from the samples and the diameters of 20 fibres measured in each mount.

(5) *Silkiness*—Up to the present there is no scale for determining the silkiness of any sample, and in any case it can only be an arbitrary one.

(6) *Fineness*—This is exhibited by the general appearance, but it is only after a long experience that one can correctly judge a quality of this character.

The spinner would always be willing to pay a higher price for some specific quality, *e.g.*, length, lustre, etc.—(THOMAS THORNTON).

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A NEW AGRICULTURAL STATION IN SIND—The Government of Bombay have sanctioned the establishment of an agricultural station in the richest and best cultivated district of Larkhana in Sind. This farm will be about 100 acres and within two miles of Larkhana on the Ghar canal. The main objects of the farm will be the experimental cultivation of rice and dry crops such as *jowar* and wheat, and the growing of garden crops and fruit trees. When this farm is established, there will be three good farms in Sind—the Mirpurkhas farm for the Jamrao tract and the farms at Sukkar and Larkhana in Upper Sind—(EDITOR).

REVIEWS.

THE REVIVAL OF AGRICULTURE IN INDIA: BY JOHN KENNY. MADRAS: HIGGINBOTHAM & CO., 1909.

THIS very interesting little pamphlet of thirty pages has been written by one who, after being connected with planting in South India for many years, has been recently Director of Agriculture in the Junagadh State in Kathiawar. Essentially, the theme is that of the necessity of co-operation among Indian cultivators, co-operation for the provision of credit, and also for the supply of seed, of implements and of manures. The whole is illustrated by a very readable account of the development of agriculture and the improvement in the economic condition of the agricultural population in several of the States of Europe.

We welcome the appearance of a pamphlet of this sort. Though there is a tendency, common, I think, to many publications on this subject, to exaggerate what has been done in some European countries, yet it is well that these inspiring examples of what can be accomplished in the course of a single generation in the economic improvement of a peasantry swallowed up in debt, should be made known to a wide public. So far the pamphlet can do nothing but good. With some of the details of Mr. Kenny's suggestions, we are not in agreement. We do *not* believe, for instance, that one of the *great* needs of Indian cultivators is a supply of artificial manures. We have little evidence, again, of the progressive deterioration of most of the land in India, which Mr. Kenny considers as certain. But though on this and a few other points we are not at one with the writer, yet his pamphlet forms as a whole a document which indicates the lines on which the improvement of Indian cultivators and cultiva-

tion can best be approached. There is little or nothing new in the information, but the restatement of an important position may itself have advantages—(HAROLD H. MANN).

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YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE, 1908: WASHINGTON, 1909.

THE appearance of the Yearbook of the Department of Agriculture of the United States of America is one of the events of the agricultural year. Ever since 1894, when the present series commenced, the annual production of a volume full of the most inspiring and suggestive articles has never ceased, and that which now lies before me is no exception to the rule. Some of us date what was almost our first strong enthusiasm for agricultural improvement to reading former issues of the American Yearbook, and the same power of inspiration seems to pervade the present issue.

As usual, the Yearbook commences with the annual report of the Secretary for Agriculture, which leaves one chiefly impressed with the idea of the vastness of his Department's interests. In the United States, the Department does not only concern itself with agriculture in the ordinary sense of the term. Among its many more general activities, it is the centre of all veterinary work, it controls the national forests, it is the referee in all questions of food adulteration, it has the meteorological department—the weather bureau—of the United States Government under its control, and so on. Hence the report, though evidently much condensed, is long,—but there are valuable and suggestive remarks in almost every page.

The second part is, however, the most characteristic of the Yearbook. This consists of a collection of articles by experts in their subjects on questions connected more or less directly with agriculture which have aroused general interest, or have been under investigation during the year, or on which it is thought that valuable suggestions can be given. This year these articles are twenty-three in number, of the most varied character, and I do not propose, hence, to attempt to review

the volume as a whole. It covers too wide a field for that to be possible in a useful manner. But I think it may be profitable to refer to certain articles, partly on account of the information which they give, but more because of the suggestive and inspiring character of their contents.

One of the most characteristic of these articles is that on "The Wastes of the Farm" by Mr. A. F. Woods, which consists essentially of a plea for intensive farming, with examples taken from the cotton belt in the United States. As is well known, the agriculture of this tract was formerly very poor, and much of it is still poor. It was conducted on borrowed money, and gave a crop which just kept the cotton farmer going. In recent years a change has taken place. The *personnel* of the farmers in the cotton belt has improved, modern implements economical of energy and labour have been introduced, a much greater variety of crops is used, better care is taken to secure good and pure seed, and co-operative marketing is being taken in hand. These lines of improvement indicate how much depends on better education on the one hand, and on better credit on the other. The lesson might well be taken to heart in many of our Indian districts.

Another paper which demands attention for another reason is that on "The Search for New Leguminous Fodder Crops" by Mr. C. V. Piper. Here the interest to us lies very largely in the fact that in America quite a number of plants which are commonly grown in India, and are not valued perhaps very much, are being introduced and boomed in the United States as being great discoveries. For instance, in the present article among others I notice the common Bombay crop *guar* (*Cyamopsis tetragonoloba* = *C. psoralioides*) is commended very highly for its drought resistance. "It is the most drought-resistant annual legume yet obtained. At Chico, California, a fine crop was produced without irrigation and without a drop of rain from the time it was planted until nearly mature." Our common *math* in Bombay (*Phaseolus aconitifolius*) also received great commendation. "The very viny branches and the persistency with which the leaves are held make an unusually fine quality of hay, which

stock of all kinds eat greedily. ...... The yield per acre during the three years in which it has been under trial averages about two tons. So far as can be ascertained in limited experience with it, it is somewhat more drought-resistant than the cowpea." *Kulthi* (*Dolichos biflorus*) and *Dolichos lablab*, known in Bombay as *wal*, also receive strong commendation. This article leaves me at any rate with the idea that crops which are proving so valuable in America may be worthy of more attention here, more especially in tracts where the fodder supply is a matter of constant anxiety.

I can only just refer to several other articles. The account by Mr. Quaintance on the spraying of orchards for insects is one of the best and most complete descriptions of what can and cannot be done in this direction that I have seen. When the question of increasing the crops in dry areas is so much before the public, the description of the effect of soil mulches in checking evaporation by Mr. Fortier will be found of considerable value. The "Systematic Rotation of Crops in Tobacco Culture" will give food for thought in our Indian tobacco districts. Several articles refer to the value of birds in keeping down injurious insects and are worthy of careful attention, and so on.

The whole volume is packed with information, and is well worthy of careful perusal by all interested in the development of Indian agriculture—(HAROLD H. MANN).

* * *

THE CHINCH BUG. BY F. M. WEBSTER, UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ENTOMOLOGY, CIRCULAR No. 113.

"FEW insects . . . . have caused such enormous pecuniary losses as has the Chinch bug. If we could have careful estimates of the loss during the last fifteen years, it would in all probability swell the amount to considerably in excess of $350,000,000 (Rupees 100 crores) for the period from 1850 to 1909." This quotation serves to show the enormous aggregate importance of this pest in the United States where it attacks wheat, barley, rye and corn. The Chinch bug is a small Lygæid

bug (*Blissus leucopterus*) represented in India by *Blissus gibbus*, which is found sparingly on sugarcane and grasses. The author describes the life-history shortly; there are, of course, no changes in it, the little active bugs coming from the egg, growing and moulting till they are fullgrown and winged; there are long and short-winged forms, the fullgrown insect black and about one-fifth of an inch long. There are normally two generations a year in the summer, and the winter is passed in hiding in matted grass, fallen leaves and other rubbish. The author lays stress on this winter period, and states that destructive outbreaks have been traced to stooks of corn fodder being allowed to stand in the fields all the winter, giving the bugs a suitable shelter; in other cases the bugs have wintered in woodlands bordering on fields and in neglected hedges. The quail, the frog and several insects prey upon it and another check is a fungus; but climate is the main factor, in that heavy drenching rains occurring at the time the young hatch destroy them in immense numbers.

The author states that "a dry June followed by a dry August is favourable to the development of Chinch bugs," these two months being the time the eggs hatch. In wet weather, the use of artificial cultures of the fungus has proved useful and have been used extensively, but as they depend upon weather, their uncertainty has led to their being abandoned. Remedies are fully discussed; they consist in burning places where bugs shelter, using the fungus in wet weather if the bugs are abundant, checking their movements by trenching, and by decoying them into special plots of vegetation where they can be ploughed into the soil and destroyed. The author also remarks: "without vigilance and prompt action, however, only indifferent results are to be expected from any of these measures." He anticipates also a recurrence of bad years, the bug having been for some years of little importance as a pest.

The United States pay great attention to insect pests, and the study of crop pests is undertaken in a very thorough way. No amount of study, however, alters the fact that the repression of such a pest depends wholly upon the co-operation of all farmers,

and that the important thing to do is the one of commonsense, destroying all materials in which the bugs winter. That is, clean cultivation, clearing up of roadsides, burning of rubbish and complete removal of the crop from the field at harvest are all-important. This is the case not only with the Chinch bug, but with very many pests, in America as in India; we have in this country no pest quite analogous to the Chinch bug, but we have many which have to spend the winter or the dry hot weather in shelter somewhere, in stubble, in grass, in rubbish, among fallen leaves, or in roadsides, and from which they issue to breed. Perhaps, no one but an entomologist can realise how important this is, but in view of the recurrence of the attacks, the United States Bureau of Entomology issues this circular, drawing the attention of farmers to the pest and detailing the methods that have been used in the past. The circular is a model of what such publications should be, appealing to the farmer by its directness and simplicity, and yet giving in plain language all the facts on which he can himself judge of the value of the measures described—(H. M. LEFROY).

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PLANT FOOD REMOVED FROM GROWING PLANTS BY RAIN OR DEW. BY LE CLERC AND BREAZEALE (REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE, U. S. A., FOR 1908).

VARIOUS experimenters in Europe and America have found, by means of the chemical analysis of plants at different stages of maturity, that the amount of such constituents as potash, phosphoric acid, nitrogen, increased until the plant commenced to form the reproductive organs, after which a material decrease occurred. This subject has nothing to do with a mere translocation of material from one part of the plant to another. It has been long established that during the maturation of plants, material passes from the leaf to the fruit, but the investigations now alluded to, had reference to the total amounts of constituents in the plant irrespective of their situation. As mentioned, a decrease was observed, and the question remains as to how this

happens and what becomes of the constituents that disappear. Wilfart, Romer and Wimmer, of Bernburg, considered that they pass down the stem into the root, and this opinion has been shared by others. Le Clerc and Breazeale, however, have come to a different conclusion. In their experiments, growing plants were washed with sprayed water at intervals during the maturing period, and the amount of matter thus washed off was estimated. It was thus found that very considerable proportions of the nitrogen, the potash and the phosphoric acid may be removed in this manner. For example, in one experiment wheat lost one-third of its nitrogen, one-fifth of its phosphoric acid and two-thirds of its potash. The amounts which are thus removable vary within considerable limits, but are always large, and the authors draw special attention to the case of grass and other fodder crops which are exposed to wet weather and which must, thereby, suffer deterioration; also that the amounts of material so returned to the soil are considerable from the manurial point of view—(J. W. LEATHER).

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REPLANNING A FARM FOR PROFIT.

FARMERS' Bulletin No. 370 issued by the office of Farm Management, Bureau of Plant Industry of the United States, America, on the subject of "replanning a farm for profit," contains many general truths, some of which may be very profitably applied to farm management in India. The Americans are a practical people. The work of the office of Farm Management is to assist by its advice farmers, in changing, where necessary, their present systems of farming, so as to get larger returns economically from the land. Wheat farming on some of the soils of the States, and cotton farming on others were at first very profitable; but continuous cropping with the same crop has impoverished the soil in many places. To survive under these altered conditions and lessened yields, farmers are advised to adopt new and more profitable systems of farming. There are many difficulties in the way, however; for farmers are conservative by nature and find it hard to change a life-long habit. "A man who has

grown up with the agriculture of a community is slow to believe that the type of farming he has followed and which was at one time profitable has at last become unsuited to his conditions. It is no easy task to think out and change his long-used type to some better kind of farming. It may mean a new line of equipment. Buildings may need modification or fences must be rearranged. It may mean introduction of commercial fertilizers or of more or different live stock on the farm. It may mean that money will have to be borrowed before the proposed changes can be effected. Furthermore, the change may not succeed. At best the taking up of a new line of farming requires re-adjustment of the usual ways of thinking and doing, a thing difficult in itself, and requiring considerable time to accomplish."

A new and better system may involve the growing of more of the most profitable crop which will enrich the soil and the giving of more attention to the live stock that has been found to pay him best, and the like. Having once decided that a change is necessary, several different systems suitable for local conditions naturally suggest themselves; but before adopting any one, the farmer is advised to estimate carefully the returns to be expected from each and the cost of carrying them out under local conditions. At this stage the average farmer is confronted by a formidable difficulty. He has not been an experimenter and has very little reliable information on any given phase of farming on which to base his calculations. He may not know the average yields of the crops that he can grow on his different fields or how these yields might be increased by manuring or rotation of crops. He may not even know what it costs him to cultivate his fields. To assist such men, the United States Department of Agriculture has established an office of Farm Management, the work of which is to advise struggling farmers how to replan a farm to make it pay. This office co-ordinates all the manifold interests of the farm into a comprehensive farm plan which omits features that do not pay, and strengthens those that do. The advice given by the office of Farm Management is

based on the results obtained at experimental stations, and on what is being done by good farmers working under similar conditions of soil and climate elsewhere.

Care is taken to base the farm plan on average results covering a period of years; for while the profits from year to year may vary considerably owing to the vagaries of the weather, visitations of insect pests or plant diseases, the rise and fall in prices of farm produce and other unforeseen circumstances, the average profits over a period of years is approximately the same.

In replanning a farm the fundamental points to be kept in mind are: (1) that the plan should provide a reasonable profit; (2) that the fertility of the soil should be maintained; and (3) that the plan should be suited to the capabilities of the owner for carrying it out.

As a concrete example of the pecuniary advantages to be derived from the practical method of replanning a farm, the Bulletin gives six different systems of farming, which may be considered suitable for the soil and climatic conditions which obtain in a certain part of the prairie tract. The live stock to be kept, the rotation to be followed, yields to be expected and net profits to be obtained, are worked out in detail in each case. The figures show that the income from the same farm can be doubled or trebled without increasing the expenditure, by simply adopting on these lines a definite system suited to the local conditions and capabilities of the owner.

But the farmer must learn to help himself. He must use his brains in deciding which type of farming he is to adopt. The aim of the bulletin is to suggest various ways of thinking about the farm and, when the time comes for replanning, the returns that may be expected from the adoption of any given plan. What the farmer requires is a comprehensive knowledge of different systems of farming gained by experience and by familiarity with what is being accomplished by others. He should be up to date in all his methods and should, as far as possible, be in touch with other successful farmers, with agricultural experts, experimental stations and colleges. He may get much

assistance, too, from a perusal of agricultural periodicals. "Many a farmer fails to get adequate returns from his farm, because he stays at home too closely...........does not visit good farmers in his neighbourhood or other parts of the country where good farming is done."

In India while the need of adopting new and more profitable systems of farming is great, the difficulties in the way of doing so are far more formidable than those experienced by the farmer of the West, for the Indian *ryot* is less intelligent and, therefore, less capable of grasping new ideas. There is a dearth of that class of advanced cultivators who in Europe and America give their personal attention to the cultivation of their land, and whose high standard of farming is in itself an object lesson to their neighbours. The Indian farmer, too, is more dependent on the exigencies of the weather; the rainfall on which successful cultivation depends so much is in his case a more variable factor. Under these circumstances he stands in even greater need of assistance than does his brother of the West. In many agricultural tracts in India to-day are to be found systems of agriculture being practised, which are as old as the hills and very unprofitable.

Of the many useful suggestions contained in the bulletin all are not equally applicable to the condition of agriculture in India. In each province in India there is a department of agriculture, which is prepared to give the cultivator expert advice on farm management, while the experts of the Pusa Research Institute are able and willing to give information on the more specialised branches of farming. The number of cultivators in India who would benefit from such information and advice is, however, comparatively small, for the average *ryot* is yet a child of nature. If we are to teach him better methods, our lessons must be in the concrete. He requires ocular proof of the advantage of any method or system of farming which differs from his own before he will adopt it. As a rule then all attempts at improvements of Indian agriculture should be based on demonstration. The non-experimental area of every experimental farm should be a

model demonstration farm for the tract it represents, and subordinate demonstration farms should be established in other sections of the tract. The greatest possible use should be made of agricultural colleges and experimental farms as educational institutions, as advocated by the bulletin. Some good can also be done by a wide circulation of agricultural papers in the vernaculars. The experts of agricultural departments in India, as in America, can give the cultivator advice, too, as to the most profitable system of farming to adopt; but in our most backward tracts our colleges, experimental farms and advice mean very little to the illiterate cultivator. To make him believe in an improved plan of farming he must first be made to see its advantages with his own eyes, and if that plan involves operations which are new to him, he must be trained to do them.

For the purpose of illustration the Raipur Experimental Farm may be taken as an example of how a new type of farming can be substituted with profit in a backward tract for that which has been practised for centuries by the *ryots*. The soil of that farm is fairly representative of that of much of Chhattisgarh, but contains only a small portion of the best rice soil. The area of the farm is 170 acres including about 20 acres occupied by roads and buildings. If leased to a cultivator, the type of farming adopted, outturns and profits obtained, would be approximately as shown below :—

Crop.	Area in acres.	Value.
		Rs. A.
Rice sown broadcast ...	38·5	787 8
Kodon and *tur* mixed ...	58·0	957 8
Dry crop wheat	24·0	480 0
Gram	10·0	140 0
Masur	7·0	70 0
Peas	4·0	40 0
Linseed	8·0	170 0
	150·0	2,645 0

The statement was prepared with the assistance of a neighbouring *malguzar*, who was thoroughly conversant with the local conditions. It was framed on the assumption that the

cultivators' cattle had free access to the common village grazing land, and that the whole area of 150 acres could be cropped. Such land, according to the *malguzar's* estimate, should yield crops worth on an average about Rs. 18 per acre. This is evidently very nearly correct as the average profits obtained under Government management for the first two years by the local system of farming was only. Rs. 19. The farm has been entirely replanned with the result that the receipts for the same period of twelve months—April to April, have risen from an average of Rs. 1,684 for the first two years to Rs. 7,095 this year. The expenditure including that spent in labour, manure and food for the work cattle, in the same time has only risen from Rs. 1,908 to Rs. 3,636; while the receipts have more than quadrupled, the expenditure has less than doubled. Incidentally the farm pays very handsomely, though at least 10% of the expenditure may reasonably be taken as unproductive in so far as it is spent on what is purely experimental work. The mere question of profit, however, is of importance only in so far as it proves that as a model, this type of farming is suitable for the tract. The merits of the new plan are: (i) that it provides for the cultivation of two new and very profitable crops, namely, sugarcane and groundnut; (ii) it has produced greatly increased outturns of rice and wheat by transplanting the rice area and by irrigating both crops; (iii) it provides for the copious manuring of part of the farm area each year with poudrette, a locally available manure which has increased the fertility of the soil; and (iv) it provides too for the reduction of the grazing area, the work cattle being largely stall-fed with fodders grown on the farm.

This new type of farming is suited to local conditions. Any fairly well-to-do cultivator in that neighbourhood can adopt it with absolute certainty that it will prove profitable if carried out properly. One enterprising member of the agricultural association has purchased land adjoining the experimental farm, which he is now working on this new plan.

Much of the dire poverty so apparent among Indian cultivators in backward tracts is due to neglected opportunities. They

do not know that there are new lines of farming more profitable than their own. They do not fully appreciate the value of irrigation, manure, and the general thoroughness in cultivation which a new and more profitable system of farming may demand. They stand in much greater need of assistance than do the comparatively intelligent farmers of America, but that assistance to be effective must be of a very practical nature. To the Indian *ryot* theoretical advice means nothing unless it is backed up by demonstration in his village. He must be convinced by ocular proof that the extra profits derived from the new system will make it worth while to adopt it, and he must be trained to perform any new agricultural methods which the system involves—(D. CLOUSTON)

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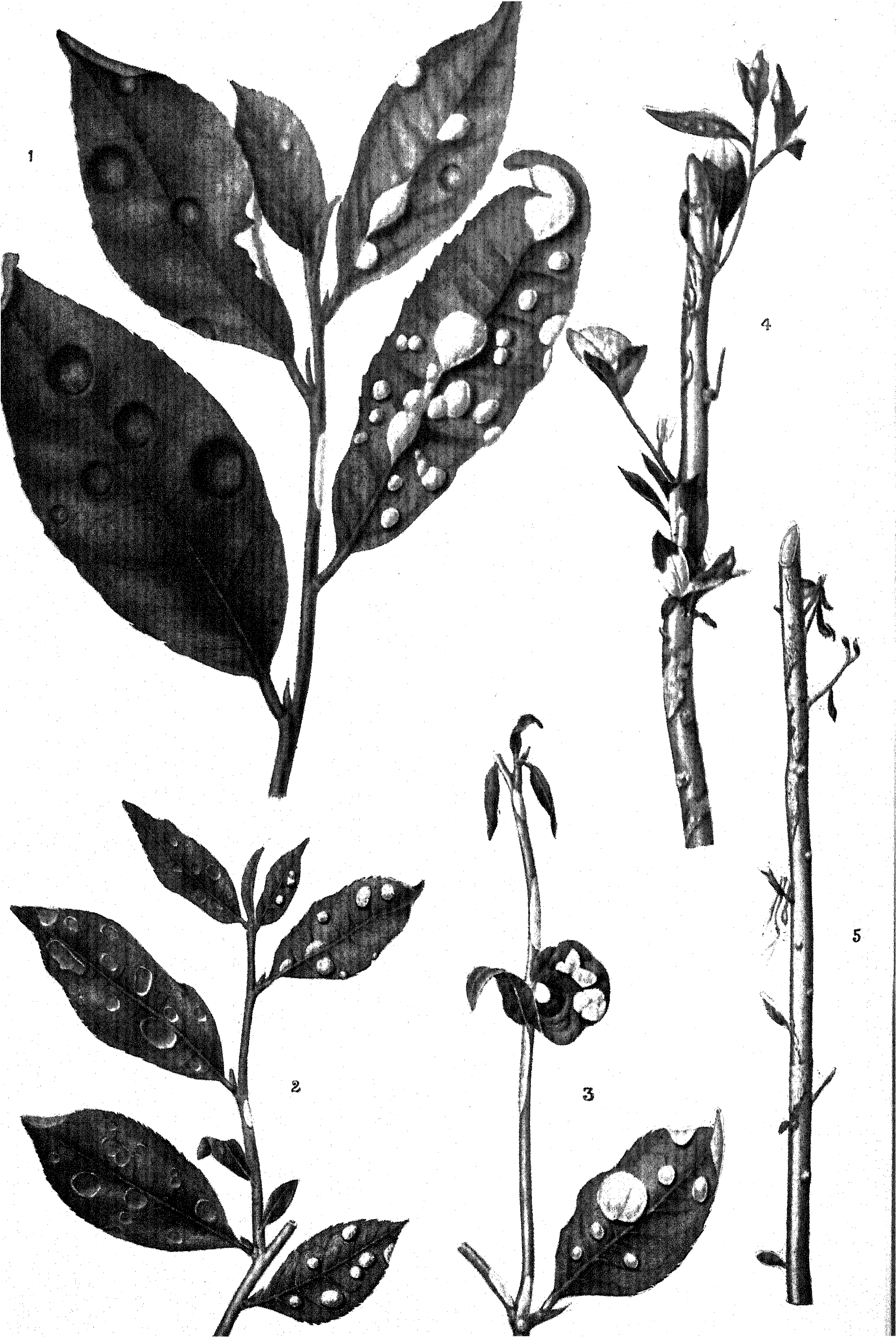
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PLATE X.

Fig. 1. Shoot of tea affected with Blister-Blight.

Fig. 2. Same showing the red tinge.

Fig. 3. Same showing the hypertrophy of the leaves and the upper flushing buds killed off.

Fig. 4. A cut-back seedling badly affected.

Fig. 5. Same with all the leaves and buds killed.

THE FURLOUGH WANDERINGS OF A DIRECTOR OF AGRICULTURE. *

By J. MacKENNA, M.A., I.C.S.,

Director of Agriculture, Burma.

3.—Holmes Farm, Kilmarnock.

The Holmes Farm, Kilmarnock, is the Experiment Station of the West of Scotland Agricultural College. It was the first, and, I believe, is still the only Experiment Station attached to an Agricultural College, north of the Tweed. The College of Agriculture has its local habitation in Blythswood Square in the City of Glasgow, but, for obvious reasons, it is necessary to go some distance out of the second city in the empire to get land suitable for an Experiment Station. The farm, accordingly, is situated about a mile from the railway station, on the outskirts of Kilmarnock—a prosperous little town, some half hour's journey from Glasgow on the Glasgow and South-Western Railway, amongst surroundings which have a considerable affinity with the agricultural conditions prevailing in the South-Western Counties of Scotland which the College makes it its aim to serve. It may be remarked that, since a visit to Canada, Principal Wright has given it as his opinion that an Agricultural College and the farm should always be together, so that it is not improbable that this arrangement may, sooner or later, be adopted.

I hope readers will be indulgent should this article go into too great detail or run to inordinate length and will remember that, in this " Wandering " my foot is on my " native heath, " and I am writing of my agricultural " Alma Mater."

While Glasgow cannot claim rank among the older schools

* Continued from Vol. IV, Part III, p. 232.

of Agriculture, it certainly is a remarkable example of healthy vigorous growth. With Edinburgh University rests the honour of being associated with the oldest definite professorship of Agriculture not only in Scotland but in the United Kingdom. History records that on July 7th, 1790, Sir William Pulteney endowed a chair of Agriculture and Rural Economy with £50 a year in Edinburgh University: the first incumbent being thus £10 a year better off than Goldsmith's impecunious parson. For many years Edinburgh was the only place in Scotland where, by attendance at the University lectures on Agriculture and allied subjects, a theoretical training in Agricultural Science could be obtained: but the whole policy of Scotch Agricultural Education has been diverted and broadened by the recognition of three distinct and separate Agricultural Colleges in Edinburgh, Glasgow and Aberdeen. Thus, instead of a vague and arbitrary course of study—detached University lectures and indefinite Laboratory work—the student can apply himself at once to a full and systematised course of study bearing directly on the main subject of Agriculture.

The history of the growth of the Glasgow College is not without interest. Originally Agriculture was simply an extra subject attached to the chair of Chemistry in the Glasgow and West of Scotland Technical College. To cope with this side of his subject the Professor of Chemistry enlisted the aid of a lecturer in Agriculture with more practical knowledge of the subject than he himself could be expected to have. Rapidly this child of the chair of Chemistry waxed strong: interest in the subject of Agriculture increased: the scope of the course of lectures was extended and, before long, the Agricultural section could stand on its own legs. Eventually a separate Lecturership, later a Professorship of Agriculture was instituted, and this central chair, with its cognate lectureships in Botany and Chemistry and its ramifications of county lectures and demonstrations formed the material from which, in 1899, was evolved the West of Scotland Agricultural College. That the ground work and the foundation had been well and truly laid by the

PLATE V.

A. J. I. BOTANICAL LABORATORY.

Glasgow Technical College may be inferred from the large measure of autonomy given by the Scotch Education Department as expressed in their circular of 1901 :—"My Lords are of opinion that any scheme of technical education would be incomplete which did not provide instruction of the very highest kind in applied science and art to selected students who will devote their whole time to study. They think, therefore, that a further differentiation of institutions is necessary and that, instead of all alike being subjected to the same set of regulations, as has been hitherto done, a few which have had an outstanding record of success in the past, which are well staffed and well equipped for a considerable variety of work, and which are situated at the natural centres of population for large areas, may be allowed to proceed upon lines of their own in the hope that they may develop into institutions worthy to rank, not in the number of students, but in quality and advancement of work, with the best of their kind in any other country. It is from such institutions, and the opportunities of research and discovery which they will naturally afford, that decisive advantage to the industries of the country, in so far as that is dependent on educational arrangements, is to be looked for."

Of the three Agricultural Colleges—one for the North at Aberdeen, one for the East at Edinburgh, one for the South-West at Glasgow—the West of Scotland Agricultural College is by no means the least. The nurse, through all its infancy, was the present Principal of the College—Professor R. P. Wright—and he has now got around him a staff which will compare favourably with that of any similar institution in Great Britain. The Botanist is Professor A. N. McAlpine who, as a Teacher of Botany, has few equals. He has a style of his own, his fund of pawky humour is inexhaustible, and you recover from a fit of unrestrained laughter to find that you have absorbed a great botanical fact. His method of teaching is of the raciest and most original type ; but it is equally effective in impressing botanical facts whether he be teaching on the most abstruse branches of plant physiology to an advanced class of students or descanting on

the common grasses to a farmer's class practically untrained in science of any kind.

Chemistry is taught by Professor R. A. Berry who, before he came to Glasgow, was an assistant in Cambridge where he did some good work in collaboration with Professor T. B. Wood. These Professors are all supplied with assistants and there is a strong staff of lecturers (employed both in the College and in Extension and County work) dealing with Agriculture and Dairying, Agricultural Zoology, Bacteriology, Book-Keeping, Agricultural Engineering, Surveying, Agricultural Law, Geology, Poultry and Bees, Horticulture, and Bacon-curing. Veterinary Science is taught by the venerable Principal McCall of the Glasgow Veterinary College and his assistants, while Forestry is in the hands of Dr. John Nisbet, late a distinguished officer of the Indian Forest Service who retired as a Conservator from Burma some years ago. His position in the world of Forestry—especially Indian Forestry—is well known and his appointment has, undoubtedly, been a great access of strength to the College. It will thus be seen that the equipment of the College is just about as complete as it can be: the only subject connected with the degree of B. Sc. which is not taught in the College itself being Political Economy. This with general pure science—*i.e.*, Chemistry, Botany and Physics—is obtained in the University of Glasgow.

The constitution of the Governing Body of the College is representative of the many-sided nature of its work. The close link between the College and the counties for whom it is expected, especially, to cater is emphasised by the large number of representatives of County Councils who find a place on the Board. Old ties are kept up by the presence, on the Board of Control, of representatives from the Glasgow Technical College and the old Dairy School at Kilmarnock. Two representatives of the University of Glasgow give it the glamour of that ancient seat of learning, while two representatives from the Highland and Agricultural Society of Scotland guarantee for it its national character.

The student who gets his first introduction to the College through its Calendar will be struck with the number of degrees and diplomas which are within the reach of his attainment. In Agriculture, the ultimate goal, if he is wise, will be the Bachelor of Science in Agriculture of Glasgow University and the National Diploma in Agriculture conferred by a Joint Board of the Highland and Agricultural Society of Scotland and the Royal Agricultural Society of England. But, as he is working to these ultimate ends, he can obtain, first of all, the Associateship in Agriculture of the College and, as he is nearing the end of his full course, the College Diploma in Agriculture (C. D. A.) (Glas.): while a student who has shown distinction in this diploma competition and has acquitted himself well in the B. Sc. and N. D. A. courses is almost certain to continue his research and obtain the Fellowship of the Agricultural College. Incidentally, during his agricultural course, he may take the Associateship or Fellowship of the Surveyor's Institute.

The Associateship of the College can be taken in two winter sessions, the Diploma takes three sessions and is, therefore, a more complete qualification. It is ordinarily taken by students who do not wish to enter the public examinations for the National Diploma or the B. Sc. degree.

In addition to the diplomas and degrees in pure Agriculture, a College Diploma is given in Dairying, and a large number of students of the College take the National Diploma in Dairying. The College also gives a course which enables students who desire it to take the Highland and Agricultural Society's Certificate in Forestry.

The above-mentioned courses of instruction form what might be called the routine work of any Agricultural College which pretends to full equipment. But, in addition to these orthodox courses, there are a number of subsidiary courses which are worthy of mention and which indicate the living and close relation which exists between the College and the general interests of the community in which it labours. For instance, to meet the modern demand for Nature Study and School Gardening (which were

things undreamt of a few years ago) courses of practical instruction are given at Kilmarnock to Glasgow Normal Students during their normal course: while for teachers already employed, short holiday courses are arranged. It is hoped that this training will qualify the teachers to give instruction in School Gardening. Each member of the class is allotted a plot, and all the horticultural operations in connection with this he performs himself. The training is thoroughly practical and, apart from its utilitarian aspect, no more healthful holiday could be devised for teachers, who, for most of the year, are confined within the four walls of a school-room.

Another quite original "side-show" is a short course of lectures given under the auspices of the Glasgow Grocers' and Provision Merchants' Association on such subjects as Milk, Butter, Cheese, etc., and the other agricultural commodities of the trade.

Last, but not least, there are the special short courses of four weeks for farmers—arranged at the time of year which interferes least with actual farming operations and to which come selected farmers from the various subscribing counties who receive a small grant to cover their expenses during their residence in Glasgow. In the words of the syllabus "the courses of lectures and laboratory instruction to be given within the month are specially designed to be of a practical character, *i.e.*, to convey to practical men the results of those scientific discoveries relating to agriculture which seem to be capable of the readiest application to actual farm practice." The lectures consist of some practical aspect of Agricultural Chemistry, *e.g.*, foods and feeding stuffs: general agricultural practice: the simpler ailments of cattle, horses, sheep and pigs: and a practical course on botany where Professor McAlpine gets full scope for his disillusionment of the popular fallacies of farmers about grasses and seed mixtures.

There is no doubt that this course, which is adopted also by Edinburgh and Aberdeen, serves a very useful purpose.

Similarly a four weeks course in Dairying is held at the Dairy School, Kilmarnock, for the benefit of practical cheese-

makers who are unable to attend the Dairy School during the summer months. This course is eminently practical: daily instruction in Cheese-making and Butter-making is given and a course of lectures on Dairying is also delivered. "The lectures are specially adapted to the requirements of practical men and are intended to convey to them a knowledge of those scientific discoveries which seem to be capable of application to existing dairy practice."

But enough of preamble: it is time that we came to the main business of this article which is the Experimental Farm of the College. As we have said, the Farm is at Kilmarnock and extends to about 200 acres, of which, however, only some 20 acres are under actual experiment, while about 27 acres are devoted to varietal experiments with oats—a subject to which Principal Wright has devoted much attention. The experimental area is hard by the Dairy School, attached to which is the section devoted to Poultry. Up till this year the remainder of the Farm has been sublet to a tenant who farmed in accordance with the general practice of the district, but in future, the whole area of the farm will be taken up by the College to admit of the conduct of stock-raising experiments on a considerable scale. The farm is equipped with an extensive range of farm buildings, containing the latest improvements in machinery, etc., and, I must say, that when one sees the equipment of these Experiment Stations at home, and, indeed, of the ordinary medium sized farm, one's mind is put at rest as to the apparent lavishness—and it is really apparent only by contrast with its surroundings—of our equipment of Agricultural Stations in India. At home they would hardly excite remark.

The points which most strike the visitor to the Holmes Farm Experiment Station are the cleanliness, tidiness and general order of the place, and, above all, the eminent practicalness of the experiments and their up-to-dateness. Nothing is missed out. The question of tobacco-culture in Scotland which has lately been discussed is brought back to one's memory by a well cultivated patch of the crop just as one enters the farm from the farm build-

ings. It is well grown and would compare favourably with our tobacco in Burma: though sheep dips and not cheroots is its destination. The effects of electricity on the growth of plants—the theory advanced by Oliver Lodge—accounts for a plot on the farm treated in this way for comparison with a plot not treated at all. These two instances are evidence that the College does not lose much time in putting to local test any new practices or theories.

Before dealing with a few of the larger and more important experiments being carried out on the farm I propose to touch on some of the demonstration plots which naturally bulk large on a farm which is at once educational and experimental. If we enter the farm at the gate adjoining the large implement and grain shed, we find ourselves in the small horticultural section. This is the area set aside for teachers: a summer class for those in employment lasting one month, and short courses of instruction for Normal teachers in training who travel twice a week from Glasgow during the session. Each member of the class has a small plot corresponding to those required in connection with school instruction. All the work—digging, trenching, planting and weeding—is done by the plot-holder. At present there are about 40 of these plots—each a pole in area: and the number is being increased. All plots are cultivated alike and the flowers, which were in full bloom, at the time of my visit, gave a welcome touch of colour. This section is also used for experiments on flowers and vegetables: varietal and manurial.

Another interesting miscellaneous group is a large collection of forage and miscellaneous plants grown on plots of $\frac{1}{400}$th of an acre which form an interesting series of demonstrations. Here amongst a large collection of English common crops are recognised such Indian friends as Indian corn (Zea mais), lucerne (Medicago sativa), Soy Beans (Soja hispida), Chick pea or Gram (Cicer arietinum), Grey field pea (Pisum sativum), Common, Blue and Siberian Melilots, Hemp (Cannabis sativa), Flax (Linum usitatissimum) and Coriander (Coriandrum sativum).

Similarly a large plot is laid out in weeds and miscellaneous plants for the use of the practical Botany class and for demonstration. For the use of students of Forestry a considerable area in the immediate vicinity of the Daiзy School has been set apart to form the nucleus of a forest garden and forestry experiment plots. In the Demonstration area "the species represented have been chosen with the view of including in the collection all those species of broad-leaved and coniferous trees commonly grown for timber in Great Britain. The shrubs include those species suitable for underwood game covers and ornamental purposes. Two specimens of each species are planted.

Then there is the Forest Area proper containing specimen plots planted with five species of trees some of which are fairly well known, while others appear to deserve more attention on account of their timber-producing qualities than they have yet had.

Finally, the Poultry Area is also planted out with shelter trees—duplicates of those in the other plots and ornamental species and varieties which at once serve as shelter for the poultry and for forestry demonstration and experiment.

An English experimental station has unequal interests for a visitor from the East, and accordingly I decided to concentrate attention on experiments which might be of interest either on account of the crops with which they dealt or of some peculiar interest in principle. Of these the famous Rotation Experiment which was commenced in 1902 and again recommenced in 1906 is by far the most important. The results of the four years—1902 to 1905—are published in the College Bulletin No. 38 which is well worth study: and contains some results of great practical value to Scotch agriculturists.

Two rotations were worked with as follows:—

No. I.—Potatoes, wheat, seeds, oats:

No. II.—Turnips, barley, seeds, oats:

both of which are common rotations in the west of Scotland.

To minimise experimental errors each rotation was repeated four times, making four series of No. I and four of No. II. The main objects of the experiment were as follows:—

1. To demonstrate the differences in the utilization and rate of exhaustion of dung or farmyard manure by farm crops.

2. To compare the merits of large with small dressings of dung—namely, 20 and 10 tons respectively.

3. Which is best—to apply fresh dung broadcast in autumn or in drills in the spring. Whether, in the former case, to plough it in at once, or to leave it spread on the surface of the soil some months before ploughing in.

4. To test the value of dung when stored in a heap and in the field with that stored under cover, and with fresh dung.

5. The comparison of dung alone with artificials alone, and of large and small dressings of dung when supplemented by artificials.

6. To compare the effect of different combinations of artificial manures and in different quantities.

7. To find the best crop or crops in a rotation to which to apply manures in either large or small, single or complete dressings, so as to determine which is the most profitable system of manuring under the conditions prevailing at the Experiment Station.

8. To show for all crops singly which system of manuring is the most economical, and any other characteristic effect arising from the manurial treatment.

The results of the experiments were in some cases different to what might have been expected, especially in the experiments on the application of farmyard manure, and at the time of their publication gave rise to much discussion and criticism among Scotch agriculturists.

With regard to (2) in which the effect of large and small dressings of dung were compared, it was clearly shown for both rotations that there is a limit to the economical application of the manure. Twenty tons as against ten tons were the quantities worked with. When applied to potatoes in rotation (1) it was found that the value of the manure per ton for the whole rotation when 20 tons were used, *i.e.*, the efficacy of the manure in terms of money in the whole rotation—was sh. 16/8, whereas

when only 10 tons were used the value per ton was sh. 25/1. Applied in the same way to turnips in the second rotation, the result was even more marked in favour of the smaller dressing.

In connection with experiment (3) above quoted the superiority of applying fresh manure in drills to the potato crop in the spring as against broadcasting it in autumn was clearly established. Twenty tons fresh dung were applied and the profit and loss for the whole rotation in Rotation No. I for each method was as follows :

	£	s.	d.
1. Applied broadcast in autumn and ploughed in at once	4	4	11
2. Applied broadcast in autumn but not ploughed in for 3 months	3	3	5
3. Applied in drills in the Spring	10	12	7

In connection with experiment (4) above, designed to test the comparative merits of (1) fresh manure as against (2) manure rotted in a heap in the field, and (3) in a heap under cover, some marked differences were got between the result in the two rotations.

In the first rotation fresh dung gave the best result, and that rotted under cover was shown to be superior to that rotted in the open. It was not, however, proved that fresh manure gives better results than the *same weight* of rotted manure as the stored manure lost 19·7 per cent. of its weight when rotted in the field and 17 per cent. when rotted under cover.

In experiments on application of farmyard manure in connection with the turnips-barley rotation the most important difference in results from those of the first rotation was in the superiority of fresh dung applied broadcast in the autumn to the residue from the same weight of dung after rotting applied in drills in the spring. The turnip increase was greater for the latter than for the former, while the increase for the three remaining crops was exactly in inverse order.

In connection with experiment (6) above it was clearly proved that it is profitable to apply dung in small quantities more than once in a rotation rather than apply one large dressing once—

a point of much practical importance. In this experiment the mixture of artificials used in Rotation No. I was 4 cwts. superphosphate, $1\frac{1}{2}$ cwts. sulphate of potash and 1 cwt. sulphate of ammonia, and in connection with Rotation No. II the turnips had applied a mixture consisting of 4 cwts. superphosphate and $\frac{1}{2}$ cwt. sulphate of ammonia. In the first rotation the addition of the artificials gave a marked increase in produce in all cases, and the best result—a total increase amounting to £14-2-11 per acre for the whole rotation—was got by adding the artificials to 10 tons of dung applied to the drills in spring. When the mixture of artificials was added to the farmyard manure in the second rotation, although an increase was got with the turnip crop the manure residue was in all cases so perceptibly decreased that the total effect of the application when 20 tons of dung were used, was to increase still more the loss for the rotation. With 10 tons a more profitable return is given for all the crops.

An interesting and important experiment was that designed to discover to which crop of the rotation the artificials should be added after applying 10 tons of dung to the root crop.

In the first rotation the best results were got when each crop had an artificial dressing applied as follows:—

Potatoes ...	... (4 cwts. superphosphate, $1\frac{1}{2}$ cwts. sulphate of potash, and 1 cwt. sulphate of ammonia).
Wheat ...	... (1 cwt. superphosphate, 1 cwt. Kainit, 2 cwts. nitrate of soda).
Seeds ...	... (same as wheat).
Oats ...	... (2 cwts. superphosphate, 2 cwts. Kainit, 1 cwt. nitrate).

The total profit for the whole rotation amounted to £11-11-3.

The second rotation gave much the same results, different manurial mixtures being used.

In connection with experiment (8) the effect of different manures on individual crops as apart from their effects on the whole rotation was investigated.

The whole series of experiments, which has been re-instituted for another four years was characterized by thoroughness, fresh-

ness of method, practical importance and opportuneness to the requirements of the day. The results of the repeated experiment will be awaited with interest by the agricultural world. The series appears to me to suggest suitable lines of work for any Department of Agriculture in any part of the world.

Another exceedingly interesting series of experiments has been carried out with the new nitrogenous manures, Lime Nitrate Ca $(NO^3)^2$—Calcium Nitrate, and Lime Nitrogen Ca CN^2—Calcium Cyanamide. The recent discoveries of the utilization of the nitrogen of the atmosphere as a manure are important, in that the supplies of nitrate of soda may one day run out; and the experiments conducted by Professor Berry are interesting, in that they test the value of these new sources of nitrogen as against the older nitrogenous manures, nitrate of soda and sulphate of ammonia. An interesting description of the process of manufacture of lime nitrate and lime nitrogen is prefixed to the account of the practical experiments which appears in the last Annual Report of the College. The latter go to show that on the whole the newer compounds are less valuable than the older.

In the experiment with oats in 1905 lime nitrogen gave practically no better return than that of the unmanured plot. When nitrate of soda and lime nitrogen were compared, each having been applied with equal dressings of other manures, the yield from the nitrate of soda was greater than that from the lime nitrogen.

In the 1906 experiment basic lime nitrate was tried and found to give a poorer result than lime nitrate, but the results of this year's experiment seemed to show that nitrate of soda and lime nitrate are of equal value as top-dressings for oats.

In experiments on hay with lime nitrogen, nitrate of soda and sulphate of ammonia, extending over the years 1904 and 1905, the conclusion reached was that the lime nitrogen, compared with nitrate of soda and sulphate of ammonia, does not appear to be as effective as a top-dressing for grass.

Further experiments on "seeds" were carried out in 1906 with nitrate of lime, basic nitrate of lime, and nitrate of soda,

amounts of these being applied to supply nitrogen equal to that contained in $1\frac{1}{2}$ cwts. of nitrate of soda. The results of the experiments showed that nitrate of soda and sulphate of ammonia have given better returns than either lime nitrate or lime nitrogen as manures for the hay crops.

In experiments with the same manures on root crops, mangels, potatoes and sugar beet were placed under trial. The results of experiments on mangels conducted in 1904 and 1905 showed that lime nitrogen, when added with dung and superphosphate, produces a yield not much inferior to that of nitrate of soda, under the same conditions. When added with superphosphate and kainit only, its action is much inferior to that of nitrate of soda. The same poor return is produced by the lime nitrogen compared with that given by sulphate of ammonia and nitrate of soda when used with dung or basic slag.

In the experiments on potatoes the conclusion was reached that for potatoes lime nitrogen is almost of equal value to ammonium sulphate when used along with dung and mineral manures, including superphosphate. But when used with mineral manures alone, and including superphosphate, it is far inferior to sulphate of ammonia used with the same mineral manures. When basic slag, however, replaces superphosphate in the minerals used without dung, the two nitrogenous manures give results of nearly equal value. If anything, the proportion of "ware" potatoes is larger from lime nitrogen than from sulphate of ammonia.

In the sugar beet experiments nitrate of soda gave, with all the three varieties tested, a larger yield of roots than that given by the other nitrogenous manures.

An important and interesting piece of work is that conducted by Professor Wright on the inoculation and manuring of the bean crop. Experiments were carried out on the College Station and on farms in the centre and south-west of Scotland during the years 1905-06.

For inoculation, cultures were obtained from the United States of America Department of Agriculture and solutions

made therefrom according to the accompanying instructions. The conclusion drawn from the experiments was that the practice of inoculating the seed seems likely to be attended with beneficial results on the majority of soils, though on some soils, like that of the College Experiment Station, no good effect was obtained. The Report says, "the addition of nitrate of soda to superphosphate and sulphate of potash would appear to be of doubtful advantage, and the cheaper practice of inoculation as a means of assisting the bean plants to secure their necessary nitrogen seems to be preferable."

The general manuring of the bean crop was taken up in 1906 and experiments were made with various "doses" of farm-yard manure and artificials. The most important conclusions obtained were: (1) that the bean crop is capable of giving quite good yields without the addition of manures at all: (2) that the most profitable returns are obtained from the application of 6 cwts. superphosphate and 2 cwts. sulphate of potash per acre applied with inoculated seed: (3) that sulphate of potash is to be preferred as a bean manure to either kainit or the "potash manure" salt used in the experiments.

Oats are the great cereal crop of the south-west of Scotland and indeed of the whole country: on their products and on the shorter catechism Scotchmen have waxed strong both in body and in the faith: and the west of Scotland College of Agriculture has made a speciality in this crop. To many the most interesting part of the College Farm is the 27 acre field on which, in plots of 1/20th of an acre, some 90 varieties are being studied for comparison as to quality and yield. So far as we could judge from a cursory inspection, the best varieties are the popular Banner Oat, Beseler's Prolific Excelsior (a small headed grain but a heavy yielder), Mounted Police, Thousand Dollar and Wide Awake: but whether they will retain their quality if introduced into the south-west of Scotland remains to be seen. Experience indicates that frequent changes of seed are of advantage. An interesting oat is the Awnless Probstei from Denmark. The earliest oat of all is Danish Island: the next

earliest Black Mesdag: and these might be worth trying in India where we have such a short cold season. An interesting sample of Chinese Naked Oat was also seen, but this showed signs of reversion. As soon as a variety seems to stand out conspicuously on the College Farm, collateral experiments are undertaken by farmers in the contributing counties, and a most interesting and exhaustive review of the results from 1902-06 has just been published in the last Annual Report of the College. This should be consulted as an example of thoroughness and completeness of work.

The first part, which is by the Professor of Agriculture, deals with the influence of soils and seasons: without going into too much detail the completeness of the work may be gauged from the many-sidedness of the conclusions which are arrived at. They show, first, the great effects of seasons on the oat crop generally: that in seasons of low temperature—especially late cold and wet spring and early summer weather—the yield of the oat crop is prejudicially affected: that particular new varieties are better both in yield and in freedom from variation than the common kinds at present grown in Scotland: but, on the other hand, they are more liable to grub attacks, and finally their requiremnts as to soil and exposure are deduced. The Botanist deals with their botanical characters and the influence of manures thereon: with the dressed grain and finally with the components of the dressed grain: firstly, the kernels and then the proportion of kernel to husk and the mealing power.

This elaborate enquiry suggests most suitable lines of work for any Department of Agriculture on any main cereal crop, and I would strongly recommend the study of this Report to any one who proposes to undertake such enquiries with similar thoroughness.

I need only refer finally, in this connection, to two other experiments on oats: an experiment to ascertain the best time of sowing, *i.e.*, whether there will be any advantage in sowing in winter, or earlier in spring than the usual time, and an experiment in thick *versus* thin seeding of oats. The standard rate is

three million seeds per acre: this is being tested against two millions and 4 millons per acre.

There are many other interesting lines of work on this experiment station into the details of which I regret I had not time to enter. Amongst these may be noted an important experiment on liming chiefly designed to discover whether a single application of lime in a large dressing or its more frequent application in small dressings will give the best results during a rotation of crops. Work on these lines will, doubtless, find a place on some of our Indian Experiment Stations. Another interesting experiment which might be copied with different crops where pasturage of cattle is undertaken, is to test whether it is profitable to sow certain seeds with lea oats as a catch crop to be grazed off in autumn and afterwards ploughed in for the maintenance of the fertility of the soil.

Then there is an interesting series on potatoes to test the comparative merits of different varieties: the use of different sized "sets" and the effect of distance in planting. The general impression is that medium sized potatoes, planted whole, at distances of from 12 to 15 inches apart give the best commercial results—with a limit on the price of the seed.

A most interesting plot is the demonstration of the effects of spraying cereal crops for the eradication of runch and charlock. A 3 per cent. solution of copper sulphate applied at the rate of 50 gallons per acre is used. The efficacy of this has been thoroughly proved, and there is no discovery of agricultural practice which has been so generally adopted by farmers. It is estimated by farmers themselves that the saving by this process amounts to as much as £7 per acre, while the cost is only some seven shillings per acre—everything taken into account.

A somewhat similar experiment, of equal interest and importance, is that on Finger and Toe. A plot of rape was found in 1901 to be badly infested with the disease. The plot was sown with turnips in 1902, so that the disease might be further propagated. The turnips were raised in the autumn and the diseased parts carefully broken up and spread over the land

equally. Various treatments were then applied and the land sown again with turnips. In 1906 all the plots were put under a rotation of crops. From the experiments on treatment made, it would appear that a heavy dose of shell lime at the rate of about 4 tons per acre, applied immediately after the last diseased crop has been taken off the land, gives the most relief. Copper sulphate, too, is good: but it is too expensive for general application.

It remains to give some account of the Dairy School attached to the farm—the only institution of the kind in Scotland and a most popular one. Here is given the only practical course of Dairy instruction in Scotland. The school is fitted with all the requisite and most modern appliances for pasteurising milk, for butter-making, and for Cheddar, Stilton and cream cheese-making. The milk of about 120 cows is handled daily during the summer, part being made into butter and the remainder into cheese. Pupils take part in all the practical work, and, in order to give better facilities for individual practice, a number of small vats for cheese-making have been introduced instead of using one or two large ones as formerly, so that students may be thrown more on their own responsibility and so, it is hoped, gain greater skill in cheese-making. Supplies of pure cultures are sent out every week from the school to farmers engaged in cheese-making in the subscribing counties and, to keep them uniform, a series of experiments have been carried out with a view to standardising the process of reproducing such cultures.

No well-equipped dairy should be without its piggery: and elaborate experiments are being carried out on the feeding of pigs, the object being the discovery of the best utilisation of whey and bye-products of the dairy in combination with other feeding stuffs.

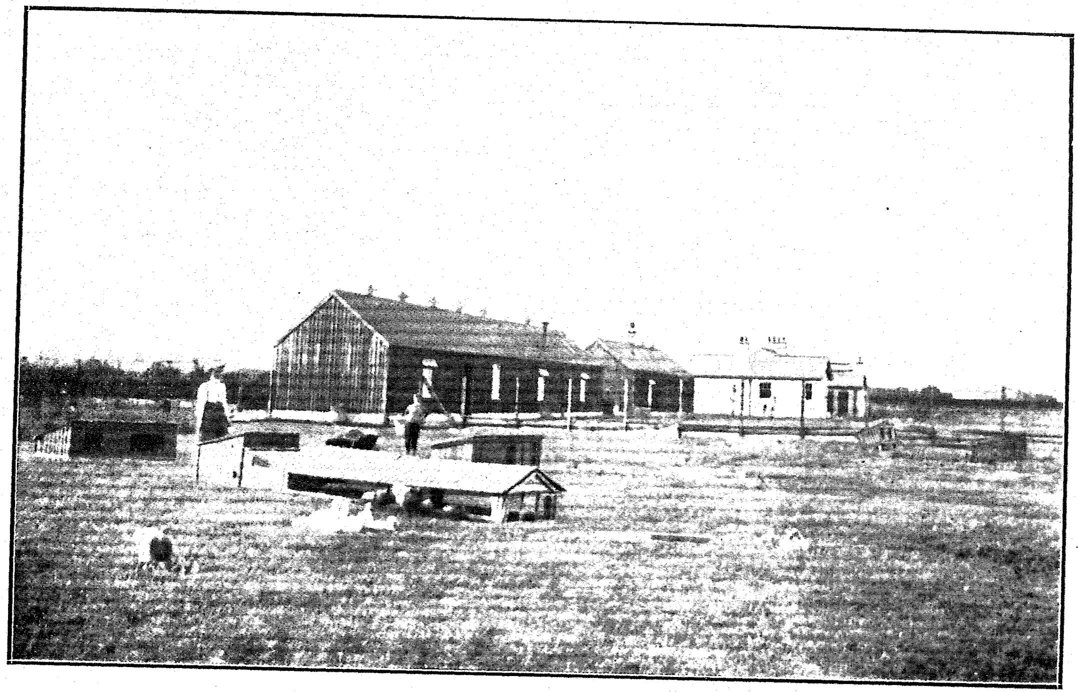
In addition to the practical work of the dairy, courses of lectures are delivered on the theory of dairying, dairy bacteriology, chemistry, milk-testing and poultry-keeping, and successful candidates obtain certificates in butter-making and dairying, or qualify for the National Diploma in Dairying (N.D.D.).

PLATE VI.

A. J. I.

DAIRY SCHOOL.

PLATE VII.



A. J. I.

POULTRY DEPARTMENT.

Last of all, we come to the Poultry Department of the farm which occupies a well selected block of some 5 acres near to the Dairy School. The aspect is bleak, but this is being improved by the judicious planting of fruit and other shade trees. A compact block of brick buildings contains an office and lecture room: incubator house, food stores and plucking and trussing rooms. The grounds are well equipped with chicken pens and poultry houses, and the comparative egg-producing powers of various selected strains of fowls are being studied. Turkeys, geese and ducks are also reared and Faverolle-Buff Orpington and Indian Game crosses are produced for table purposes.

Courses of instruction in the practical handling of poultry can be arranged at any time. The instruction includes the use of all modern appliances connected with the natural and artificial methods of hatching and rearing chickens, ducks, geese and turkeys and the feeding, fattening, killing, shaping and dressing of table poultry. In addition two special courses of ten weeks are given. These include, with all aspects of the practical work, a course of lectures on the Theory of Poultry Breeding and Handling.

On the whole, it would be difficult to find a more fully equipped Agricultural Station, and I can confidently recommend any one, who has the opportunity, to visit it.

AGRICULTURAL IMPROVEMENTS IN CHHATTISGARH.

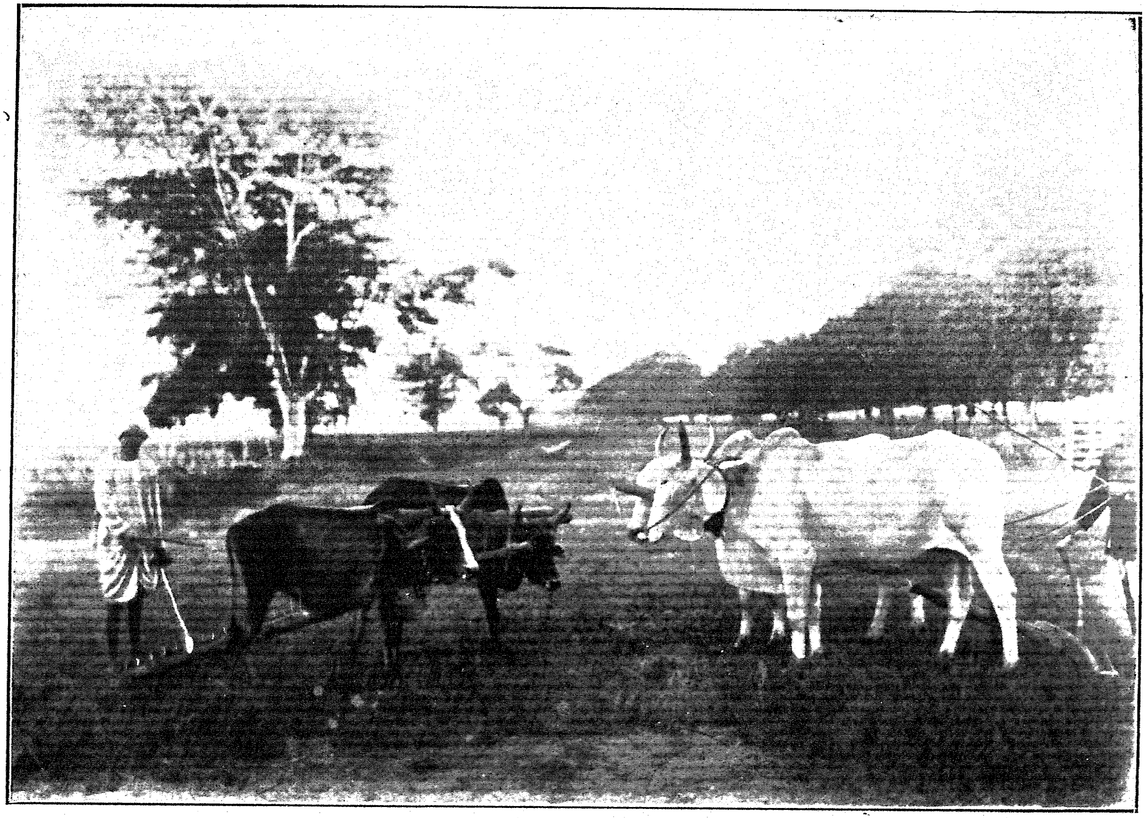
By D. CLOUSTON, B.Sc.,

Deputy Director of Agriculture, Central Provinces and Berar.

CHHATTISGARH is the most backward part of the Central Provinces. The Chhattisgarhi is recognized by his fellow cultivators of other parts of the Provinces as being lazy and resourceless, and his cultivation as being of the very poorest kind. This is due partly to lack of enterprise and partly to conservatism which are the hereditary instincts of the people; but partly also to their poverty and other difficulties under which they labour. Some races are born cultivators, and take a pride in their work; the average Chhattisgarhi is not one of these; he works that he may not starve.

The division, as a whole, is flat and land-locked by hills. There was no trade to speak of till the country came under British rule in 1854. With the opening of the railway between Nagpur and Bilaspur in 1892 trade was still further developed and prices of rice and other grains gradually rose. In 1862 the price of wheat was 83 seers per rupee, and of rice 70 seers, as compared with 10 seers and 20 seers respectively at the present time. But the average Chhattisgarhi has not yet learned to take full advantage of these better times. Sufficient unto the day is the evil thereof would seem the extent of his ambition in farming.

Their conservatism is due to their isolation and ignorance. They still stick to their old cropping system; grow *kodon* (Paspalum scrobiculatum) and *kutki* (Panicum psilopodium) on good soil where far more profitable crops of wheat or groundnut could be grown. They broadcast their rice instead of transplanting it, and until the last three years, seldom irrigated



A. J. I.

CHHATTISGARH AND GOALAO BULLOCKS.

their rice, and wheat never. But the poverty of the ordinary Chhattisgarhi ryot also helps to account for his lack of progress. Many of them have been disheartened by repeated famines and years of scarcity. His bullocks are small and thin, and too weak to cultivate his land properly.

To introduce agricultural improvements in any tract one must study (1) the cultivators of that tract and the difficulties under which they labour, (2) the soil and climatic conditions, and (3) the cropping systems in vogue. The low standard of cultivation in Chhattisgarh is partly due to the inferiority of the work cattle. The ordinary work bullock is only 36″ behind the hump. None but well-to-do cultivators can afford to purchase buffaloes. Another obstacle in the way of progress is the loss of crop and cattle in years of short rainfall and its resultant distress, which demoralises the ryot and throws his cropping system out of joint. While the average rainfall at Raipur for the last 40 years is 53·30 inches; it fell to 22 in the year 1900-01. The success or failure of the rice crop depends largely on the seasonable distribution of the rainfall. Years of scarcity have generally been due to the comparative failure of the rains during the latter half of September and the first half of October. Ample facilities for irrigation is the only means possible of averting such disasters.

The soils of this division are mostly of laterite origin. They may be divided into four distinct classes. The partially decomposed laterite rock of the higher lands, which gives a reddish gravelly soil, locally known as *bhata*, is the typical soil of large high-lying ridges covered with scrub and stunted grass, some of which bear at intervals a poor crop of the lesser millets, *kodon* and *kutki*. The *bhata* grades gradually into *matasi*, a fine-grained yellow loam which is considered the ideal soil for paddy in this tract. *Matasi* like *bhata* is unsuitable for double-cropping on account of its tendency to harden after the rains into a brick-like mass, which it is almost impossible to reduce to a fine state of tilth by means of the cultural implements in use in this tract. Moreover, it does not retain moisture well.

Dorsa or *dorasa* (meaning two kinds) is a mixture of *matasi* and *kanhar* ; it is dark grey in colour, grows rice and *rabi* crops fairly well, and is, therefore, suitable for double-cropping. *Kanhar* is a dark loamy soil found at still lower levels ; it contains less sand, and if pure, no nodules of limestone ; it is very retentive of moisture. *Kanhar* is the best wheat-producing soil of the tract, but is not so good for rice, being too heavy. Dr. Leather's analysis of these soils is given below :—

	Matasi.	Dorsa Soil.	Kanhar Soil.
Insoluble silicates and sand	87·41	74·68	69·73
Ferric oxide	4·12	6·71	7·64
Alumina	4·78	11·43	13·83
Lime	0·28	0·85	1·05
Magnesia	0·30	0·81	0·75
Potash	0·43	0·86	0·79
Soda	0·13	0·20	0·25
Phosphoric acid	0·02	0·02	0·02
Sulphuric acid	Very little.		
Carbonic acid	0·13	0·09	0·08
Organic matter & combined water ...	2·40	4·35	5·86
	100·00	100·00	100·00
Total Nitrogen	·053	·041	·036
Available phosphoric acid	·001	·001	·001
Ditto do. potash	·010	·011	·012
Equivalent to calcium carbonite	·30	·20	

The cropping system in vogue in this division is of the simplest kind; rice, *kodon* and *kutki* are the chief rain crops. The *kharif* crops are by far the most important; of the total cultivated area of 4,704,168 acres rice alone occupies 3,020,154 acres, and *kodon* and *kutki* 618,803 acres. The value of a good crop of the latter, though it is often grown on the best black soil, does not exceed Rs. 10 an acre. It requires, however, very little cultivation and its seed rate is only 9 or 10 lbs. an acre. It is the chief crop on which the ryot falls back should his rice fail. In the absence of irrigation he has learned by bitter experience that all he can hope to do in bad years is merely to survive. His cropping system is, in consequence, largely a shift to avert the distress of famine. The chief *rabi* crops grown are, linseed, wheat and pulses of

different kinds : linseed and the pulses being largely grown on the best black soil as a second crop after rice.

In carrying out its demonstration work this Department has had to study and to deal with these difficulties one by one, fully realizing that the average ryot was adverse to any change in his methods of husbandry, and that he would act as a passive resister should these be forced upon him. To ensure progress the Department has worked through the leading and more enlightened men in each village. In most cases the leading man is the Malguzar. When the Malguzar is once convinced that a new method of cultivation will pay, his tenants follow his example in adopting it. In some villages almost every tenant now transplants at least a small area. The members of the Agricultural Associations have also given great assistance. With bad cultivation, irrigation, transplantation and other improved methods are almost void. The difficulty of tilling his soil properly with the small bullocks at his disposal has partly been got over by hiring out buffaloes to cultivators for the *kharif* season at the rate of Rs. 5 per pair.

The work of raising the cultivator from the slough of poverty and despondency will necessarily be slow, but it will come gradually as the result of his adopting the more profitable methods of farming based on the extension of irrigation which will ensure him against years of scarcity.

The most formidable difficulty that the Department has to face in tackling this great problem of agricultural improvement by demonstration has not been in devising effective methods of introducing necessary improvement, but in getting a sufficient number of suitable men to carry them out on a fairly large scale. A practical expert will always keep in mind the fact that his duty is to devise methods, organize his staff and to supervise the work sufficiently often to see that it is carried out properly. The members of that staff should be intelligent practical men who can gain the confidence of the cultivator.

Another line of work that is being taken up on the Experimental Farm is that of training the sons of cultivators and orphan

boys in practical agriculture. Courses have been arranged by which these can get a training in the method of transplanting rice, of irrigating wheat, of cultivating sugarcane and groundnut and of growing fruit and vegetables. The Experimental Farm thus serves as a most important centre for agricultural training as well as research.

This Department has for the last 3 years worked in hearty co-operation with the Irrigation Department. The latter supplies water; the former induces the ryots to use it for their crops. This has been no easy task; for the Chhattisgarhi had never been accustomed to pay water rates. When in years of good rainfall there was water available in the village tank, he got it free of cost. For three years the advantages of irrigation for rice and wheat have been demonstrated to him in his own village. He has been encouraged to transplant a late heavy-yielding rice, every acre of which has had to be irrigated. He has been induced, too, to irrigate his wheat. That this Demonstration has been effective and that the ryot is now beginning to appreciate the value of irrigation, is evident from the Statement given below.

Particulars.	1906-07.			1907-08.			1908-09.			1909-10.			REMARKS.
	Area actually irrigated.	Maximum rate.	Average rate.	Area actually irrigated.	Maximum rate.	Average rate.	Area actually irrigated.	Maximum rate.	Average rate.	Area actually irrigated.	Maximum rate.	Average rate.	
		Rs. A.			Rs. A.			Rs. A.			Rs.		
Rice ...	1,272	1 4	0·60	23,693	1 4	0·69	21,853	2 0	0·93	25,374	2	1·41	
Wheat ...	672	1 4	0·93	2,248	1 4	1·15	2,113	1 8	1·50	not known	2	...	

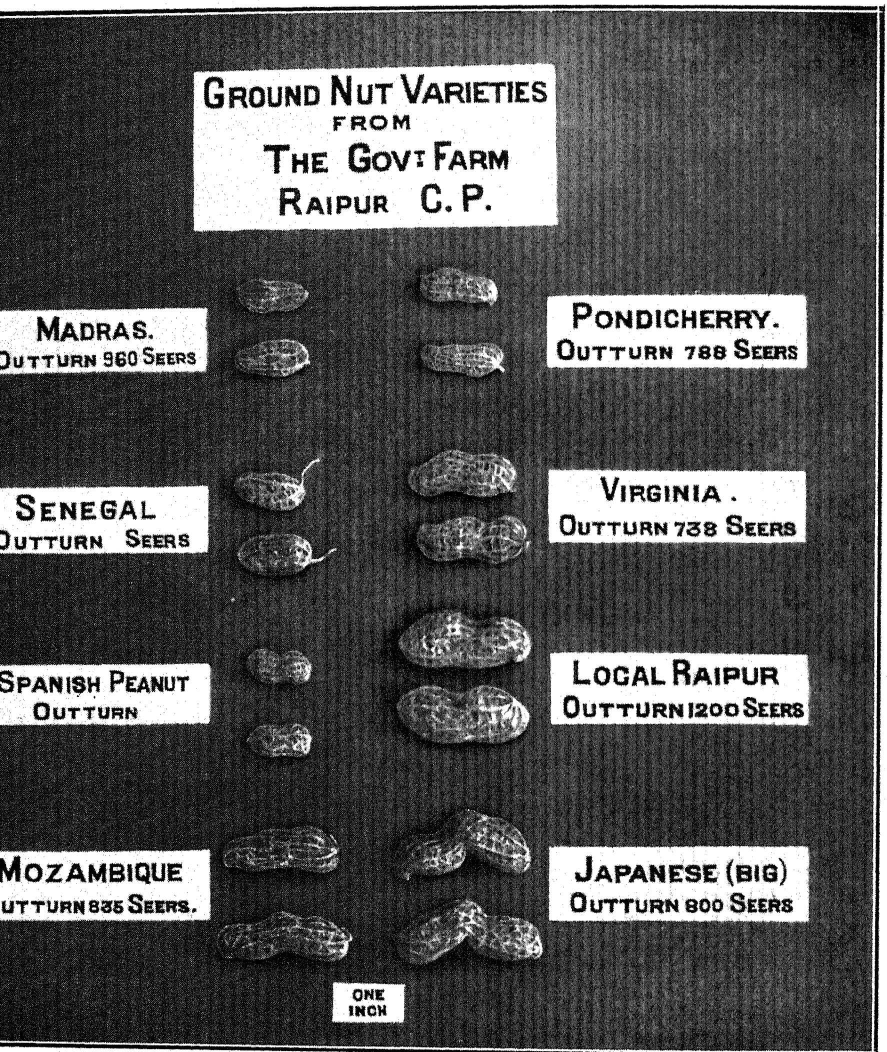
For each assistant an area including from 8 to 10 villages, the land of which is irrigable, is selected. This area is known as a Demonstration centre. The advantages of the new method are demonstrated in the villages of the circle and as many ryots as possible are induced to adopt it in the same season. But there

is a wide gulf between the agricultural assistant and the village ryot of this tract. The ryot is generally an illiterate but practical man who works with his own hands; the agricultural assistant in the Central Provinces is in his own estimation a superior person and does not believe in the dignity of manual labour. His true sphere is supervision. For demonstration work another class of man is also required, who will demonstrate with his own hands the new method which is to be introduced. In transplantation, for instance, the Chhattisgarhi ryot has to be taught all the processes. For this we require a more practical class, who will themselves work daily among the ryots, and who are sufficiently intelligent to correct their mistakes and to carry on the work in the absence of the agricultural assistant. For the last two years skilled men have been imported from other districts where rice cultivation is seen at its best. These were employed during the rice season only. Some of these were afterwords engaged by Malguzars as managers. The three objections to this system were : (1) that difficulty was experienced in getting suitable men for so short a time, (2) it did not provide for the permanent employment of the very best men, and (3) though expert in rice cultivation, these men had little or no knowledge of the other demonstration work. It was, therefore, decided that the best of them should be given permanent employment in the Department. Fifteen were appointed last year and the number will be gradually increased. They are paid from Rs. 9 to Rs. 10 a month, rising to Rs. 15, and have been designated Kamdars. In the work required of them other than transplantation, they will undergo courses of training on the Raipur Farm. With a Kamdar as the unit for one or more villages, and an agricultural assistant as the unit for the Demonstration Centre and the Superintendent of the Farm as the unit for the Division, it will be possible to extend demonstration work very rapidly. The scheme is a practical one; it enables the Department to do a large amount of work at a very small cost. It may be applicable, too, to other parts of India where the standard of cultivation is low.

To make demonstration work successful the village demonstration plot should be a concrete example of the advantage claimed for the new method. Failures are fatal. In this the Department has been very fortunate. The increase due to transplantation as compared with *biasi*, *i.e.*, rice sown broadcast, was tested in 17 villages in the demonstration centres in 1908 and in 32 villages in 1909. *Biasi* gave an average outturn of 1,593 lbs. per acre and transplanted rice 2,685 lbs., or an increase of 1,092 lbs. In 1909 the *biasi* fields tested, yielded an average of 1,356 lbs. per acre and transplanted rice 2,043 lbs., or an increase of 687 lbs. The percentage of increase due to transplanting was 68·5 in 1908 and 50·7 in 1909, the money value of which is Rs. 27-12 and Rs. 17-3 per acre respectively. The plots were irrigated and carried late rices in each case, which accounts for the comparatively high outturns. The increase due to irrigation alone where *biasi* rice was grown, was tested in 26 villages last season and was found to amount to 585 lbs. on black soil and to 625 on *matasi*, the money value of which was Rs. 14-10 and Rs. 15-10 respectively. This corresponds to an increase of 80% for black soil and 86½% for *matasi*. The average increase last year of grain per acre due to the irrigation of the wheat demonstration plots was 356 lbs. worth Rs. 27-7.

Another line of agricultural improvement now being carried out is the introduction of more profitable crops than those at present grown. In touring through this division in the rains one is at once struck by the large area of good black soil cropped with *kodon* and *kutki* and other unprofitable crops. Under these two crops alone there were 618,803 acres last year. The average yield per acre of which is valued at Rs. 10. Though unprofitable, he continues to grow these ; it is hard to change a lifelong habit. To remedy this the Department is introducing groundnut and sugarcane, crops which do very well in this tract when the water supply is sufficient. Of groundnut 8 varieties have been tested on the Raipur Farm ; it has proved a most profitable crop when grown in black soil, *i.e.*, *dorsa* and *kanhar*. In the varietal test the average net value of the outturns ranges from Rs. 55 to

PLATE IX.



I.

VARIETIES OF GROUNDNUT.

Rs. 114 per acre. The local variety is the heaviest yielder; with the exception of Spanish peanut it is also the first to mature. This local variety is now being introduced. That grown by members of the District Agricultural Associations last year gave an average outturn of 1,740 lbs. per acre, worth Rs. 108-12; the demonstration plots yielded 1,650 lbs. worth Rs. 103.

The cultivation of new varieties of sugarcane is also being demonstrated at the different centres, but with this crop the results have not been quite so good, for thick canes require much manure and careful attention. It is too critical a crop for the average careless Chhattisgarhi to grow; he neglects it and it gets infested with sugarcane borer. Seed is therefore being supplied to the best cultivators only. For this very practical suggestion I am indebted to the Inspector-General of Agriculture who inspected some of the Demonstration Centres last year. At present the average ryot is a man with little or no capital. He is often badly in debt to the village *Sowkar* to whom he pays an exorbitant interest. He cannot therefore afford to take risks by growing a new crop such as cane, the seed of which is very expensive. To alleviate his condition the Department gives out the seed of such new crops as sugarcane and groundnut on easy terms. The cane is given on loan on condition that the same quantity of seed is returned at the end of the year; groundnut for seed is supplied at half price.

All the agents employed in raising the standard of cultivation in this tract are in close touch with each other. The experiments conducted on the Raipur Farm give the cue to the improvements to be introduced. The Demonstration Centres are the connecting links between the Experimental Farm and the cultivator. The non-experimental portion of the farm serves as a model demonstration centre, and is a miniature of what we hope the cultivated area of many villages in Chhattisgarh will be 10 years hence. The assistants employed at the Demonstration Centres meet together on the farm once a year and the plan of operations for the succeeding year and difficulties connected with

their work are considered. The farm is a training ground, too, for the Kamdars, cultivators and orphan boys, each of whom is expected to do something for the advancement of agriculture in this benighted tract.

From the results already obtained it is certain that by working on these lines the productiveness of the soil and the farming profits derived therefrom can be increased enormously within a very few years. The cultivation of groundnut has been taken up at all the centres and an area of over 4,000 acres of rice was transplanted and irrigated last year. But the extent to which improvements can be introduced will depend very largely on the irrigation facilities available. The present sources of irrigation are from wells, nullahs, village tanks and Government tanks. Of these the first three are unreliable, as they nearly all fail to supply water for irrigation in years of short rainfall. The area irrigable from Government tanks in this Division is at present only about 32,000 acres.

As such a limited area offers but little scope for any great extension of agricultural improvements, the department will have to seek fresh fields in comparatively few years. One large irrigation project, *viz*., the Tendula Canal, has already been sanctioned, which will irrigate annually an area of 263,000 acres, whilst the Mahanadi Canal, which is at present under consideration, will irrigate 360,000 acres: but many years must elapse before these schemes are finished works.

As to what water-rate the ryot can afford to pay is a question of some importance, in so far as the construction of future irrigation works will, to some extent, depend on that rate. After three years' experience of irrigation he has this year paid Rs. 2 per acre for *kharif* and *rabi*; but he can well afford to pay Rs. 5 for the full irrigation of late rices, groundnut and wheat, and four times that amount for the better canes now being supplied by the department. In a normal year irrigation should increase the value of his rice by about Rs. 15 and his wheat by more than Rs. 20. In a year of very short rainfall it will mean insurance against the failure of his crops, and the consequent distress which

follows in its train. Irrigation facilities will be to him an incentive to grow more profitable crops and to get better work cattle. With these advantages at his command we believe that even the Chattisgarhi will become more enterprising, more thrifty and more prosperous.

THE OUTBREAK OF BLISTER-BLIGHT ON TEA IN THE DARJEELING DISTRICT IN 1908-1909.

By W. McRAE, M.A., B.SC.,

Offg. Imperial Mycologist.

In June 1908, near the head waters of the Balasan River. leaves of the tea plant were observed to be attacked by Blister-Blight. Gradually the blight spread from garden to garden, and in October it was noticed on gardens on the Tukvar slopes. This was the first appearance of blister-blight in the district of Darjeeling. The disease is not a new one on the tea plant, but hitherto it has been confined to the Brahmaputra Valley in Upper Assam, where it was investigated and described by Sir G. Watt in 1895. It has existed in that region for over 40 years. These two places are widely separated, yet the blight has not been reported from any of the intervening tea districts of Cachar, Sylhet or the Duars. In this year it did not do much damage and in the cold weather died down.

In 1909 the blight appeared again but earlier in the season, *viz.*, in March. During the summer it showed for the first time on other gardens. Everywhere it spread rapidly till hardly a garden in this part of the district is now free from blight.

The first indication of a blister is a small, pale green, yellow, or pinkish translucent spot easily seen against the darker green of the rest of the leaf when it is held up to the light. Sometimes the pinkish tinge fades or it may never be discernible. In other cases the spot is deep red on both sides like red ink, and the red tinge remains even when the spores are ripe. The circular spot enlarges, usually reaching a diameter of $\frac{1}{4}$ to $\frac{1}{2}$ inch. On the upper side of the leaf the spot gradually becomes depressed into a shallow cavity and on

PLATE XI.

FIG. 1.

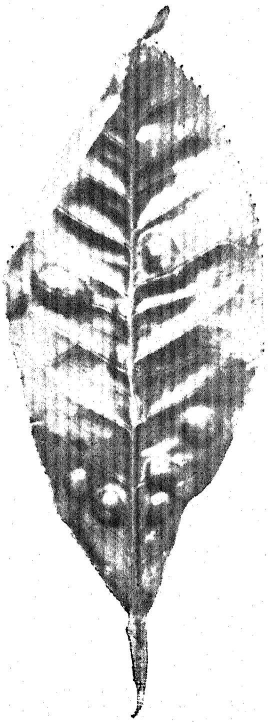


FIG. 2.

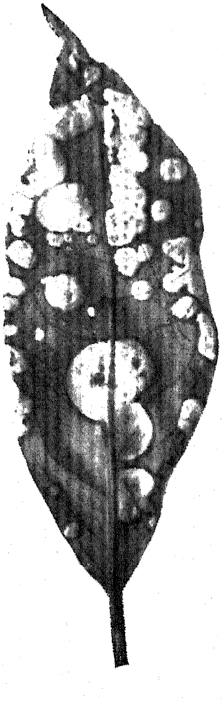


FIG. 3.

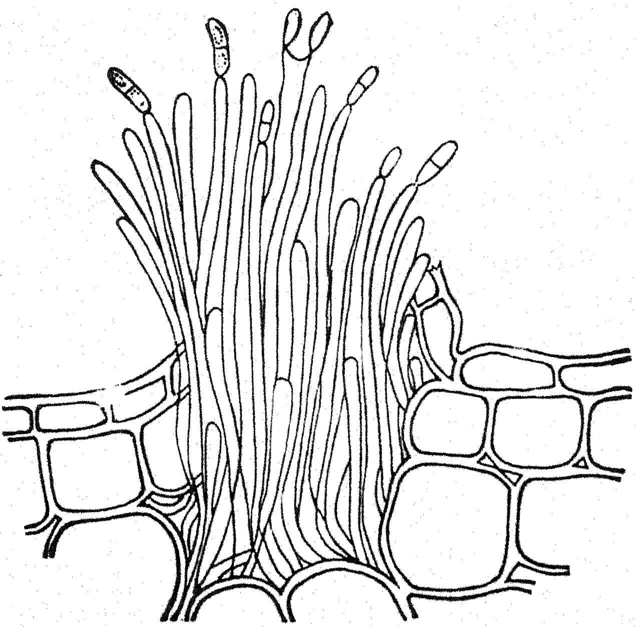
BLISTER BLIGHT OF TEA.

the under side it bulges out slightly, thus forming the blister from which the blight takes its name (Plate XI, figs. 2 and 3). The upper concave circular area is smooth and shining and the colour is usually paler than the rest of the leaf. The under convex surface, on the other hand, is dull and at first is grey as if dusted with white powder but when mature it becomes pure white. The lower surface produces colourless spores which with the outgrowth of fungus filaments give the white appearance to the under side of the blister and on some vigorously growing blisters slightly to the upper side also. In not a few cases the form of blister is reversed and both forms may be found on the same leaf; but the spore-bearing surface is always principally on the under side of the leaf. After a time the white blister becomes discoloured till it is dark brown or black, then it becomes dry and shrinks till the discoloured patch is in the same plane as the rest of the leaf.

After the leaves of a bush have been attacked the disease spreads to the leaf-stalks and the young, succulent, green stems, but here the appearance of the disease is not so conspicuous though the damage is much more serious. The course of the disease on the young delicate stem is like that on the leaf only no blister is formed. The colour of the spot is very similar, but the deep red tinge is wanting. The spot becomes elongated and also gradually spreads round the stem. At this place the stem becomes slightly swollen. When the spores are ripe they give a grey appearance to the spot but it does not become pure white like the blister. The disease eats through and the leaves and buds on the green stem above wither and blacken while the stem bends over and falls off at the diseased part. Several of these dead twigs on a bush give it a black, unsightly appearance.

When a thin section of a blister is looked at under the microscope fine colourless threads (hyphæ) of the fungus are seen between the cells of the leaf. These come to the surface on the white side of the blister and produce spores at their ends. There are two kinds of spores. The first is two-celled and is

produced at the end of a long stalk. The second kind is one-celled and is produced on a very short, thin, stalk from the swollen end of a hypha. In the latter case spores are always produced in pairs.



Section of a small part of a leaf of the tea plant showing the hyphæ of the fungus bursting through the surface of the leaf and bearing (1) two-celled spores singly and (2) one-celled spores in pairs.

When kept in a moist chamber on a slip of glass or on the surface of a fresh tea leaf the spores swell slightly and germinate within 5½ hours of being sown. From each of the cells of a two-celled spore or from the one-celled spore a thin tube grows out, increases in length and enters the leaf by a breathing-pore. When inside it branches freely and gets its nourishment from the cells of the leaf. After a period of eleven days the translucent spot is clearly visible and in from six to eight days more the blister is formed and the hyphæ produce spores.

If a blister is situated on the midrib, the leaf often folds or rolls upon itself irregularly, sometimes the lower and sometimes the upper surface of the leaf remaining outermost. If several blisters occur near the margin, the leaf often becomes curled and twisted in the most fantastic manner. The number of

PLATE XII.

A. J. I. TEA BUSH AFFECTED BY BLISTER BLIGHT.

blisters on a leaf varies from one up to about twenty, and they may be isolated or several may run together to form a large patch with an irregular outline. To such an extent does this sometimes go that the whole under surface of the leaf may be covered with an even mass of blisters.

When many of the leaves on a bush have even only a few blisters each, the damage done to the bush in reducing its green surface available for food-making is great and in addition the parasite is draining the host bush of the nourishment made for it by healthy leaf tissue. When the vitality of the growth is lowered the healthy flushing of the young leaves and buds is retarded causing considerable loss. When the disease runs unchecked through a bush and the young shoots have fallen over and decayed it has a black, unsightly appearance quite justifying the anxiety of the managers on those gardens where the disease is prevalent.

The exact place in the district where the disease first occurred cannot now be settled with certainty, but it was most probably on the slopes on the southern side of the Senchal ridge. Last year it was noticed at several places near the head waters of the Balasan River almost simultaneously. After it had once been reported it was found on quite a number of gardens. From this it may be conjectured that the rate of dissemination of the disease was very rapid or that it may have existed in the gardens for some time without having been noticed. This last may quite well have occurred in gardens where it was doing little real damage especially as the disease was new to the district and was then unknown to many planters. From observations made this year the former also seems to be the case, and when once the blisters have matured the spores, which they produced, quickly become distributed.

When blister-blight appears on a block scattered bushes are affected, some badly and others slightly. Only one or two leaves on a bush or a few more or a great many are blistered. A block may appear quite healthy till suddenly a few blistered leaves will be seen, and this occurs in a noticeable way when a spell of wet

weather recurs after a few days' sunshine. Little damage may be done or the blight may become worse and worse, both mature leaves and flushing shoots becoming affected, then blackening and dying till leaf-picking is stopped.

The spores of the parasite are distributed by the wind and the quick distribution can be understood when one remembers the fairly strong breezes that occur here. On days in which there are a few hours of dry weather or sunshine, the wind will blow the light dry powdery spores about, and they may be borne a considerable way and scattered over a comparatively wide area. In the Balasan Valley strong breezes blow up the valley, especially in the evening of a hot day, and the blight has travelled much more rapidly and is more severe towards the head waters than downwards towards the plains. In this valley the disease is severe on slopes exposed to the wind, *i.e.*, on southern slopes. On the Tukvar side of Senchal the winds are not so steady and are more irregular in direction, and here the distribution of the disease is erratic.

The blight attacks the high quality Assam and hybrid jâts most severely, while China and Manipuri are not so much affected. It is quite interesting to see, in some China blocks where Assam or hybrid bushes have been used to reset empty places, how the leaves of the two high quality jâts are well infected with blister whereas the leaves of the China are almost free. Yet in some gardens China is very badly affected and the bushes have a woeful white or black appearance according to the stage of the disease.

With respect to heavy pruned, lightly pruned and unpruned tea it is difficult to say definitely that one is attacked more often than another but, when once the blight has come, the damage done is in the order of mention. In the young, succulent rapidly-growing leaves of heavy pruned tea the blight developes vigorously and may destroy nearly all the leaves that ought to go to form growth leaves. Now for a good framework of new wood a heavy pruned bush depends mainly on the growth made in the first year after heavy pruning. If then in the first season much damage is

done to the leaves growth is checked, thus causing serious loss in crop in the following season.

The blight is worse on places with a high rainfall and worst about that elevation where rain falls nearly every day and mists are constantly hanging about. Thus on the slopes of the Rungbang and Balasan Valleys facing the plains the blight is on the whole worse than on the Darjeeling side of Senchal. The blight seems to be more severe at high elevation and worst between 4,000 and 5,500 feet. Not elevation, however, but moisture is the real factor with regard to severity. In this district high elevation means, within certain limits, high and evenly distributed rainfall. The three worst blocks and the only extremely bad cases on a large area seen by me were on gardens between 5,000 and 5,500 feet. Whereas in a low elevation garden in the Rangit Valley, the blight came late in the season of 1909 and was only very slight ; one had to search to get blistered leaves. Too much shade whether artificial from planted trees or from proximity to jungle favours the blight and it is worse too on damp, shady hollows. It was found that the bushes under the trees grown for shade in the garden were often affected when the surrounding unshaded bushes were free from blight, and when both were affected the shaded bushes were more severely blistered. This occurred under old trees that were giving more shade than was really necessary, and suggests the thinning of jungle trees near the tea and lopping off branches where shade-trees have become too dense.

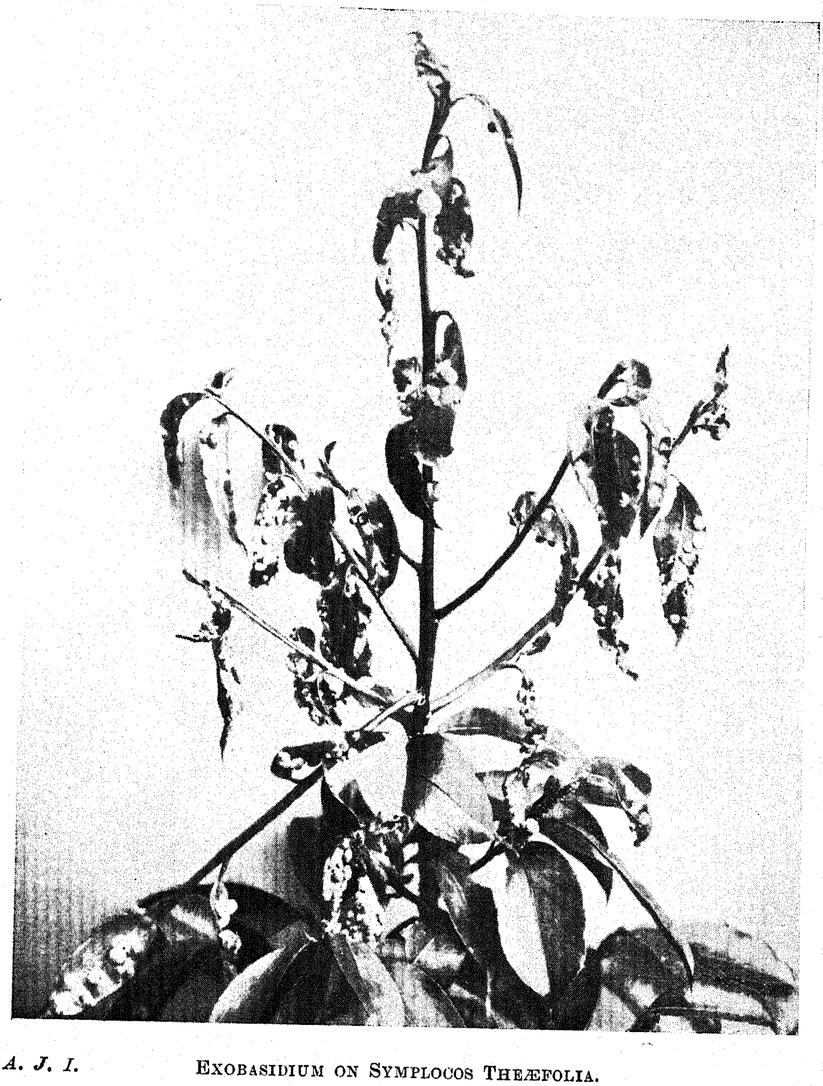
The amount of damage done by blister-blight this season is difficult to gauge. Fortunately for the industry weather conditions were favourable from April to June and gardens flushed well, getting thus well ahead of their usual average. They have, however, since gone down and some gardens are well behind. The greater loss is attributable to wet, unfavourable weather in July and August and a considerable portion to blister-blight. The worst damaged piece of tea was a heavy pruned block. Ninety per cent. of the plants had lost all their leaves or the leaves were all blistered. As soon as a bud sent forth a leaf it was attacked.

The year's growth had failed, and most of the bushes will start next spring as if they had been just pruned unless, as is more likely, they start weakened by the lack of growth this season. In new-extension young plants often suffer badly (see Plate X, figs. 4 and 5). In one seed bed, all the seedlings were destroyed by blister-blight, and as the cost of the seed and of upkeep amounted to Rs. 770, this was a dead loss. On Dooteriah Division in the two seasons over 900 maunds of blistered leaves were picked and destroyed of which about one-sixth might have been made into tea, the remainder being mature leaf. The cost of collecting this amount of blistered leaf was Rs. 657. At Tukvar the loss this year is about 30 maunds of tea. These are average examples of loss, but some gardens have lost much more and others much less. No account has been taken of the damage due to lowering of tone and weakening of the bushes.

How the blight came to the tea plant in this district is not definitely known. It may have been imported into the district from Assam or have come from the jungle. Every year small quantities of seed are imported into the Darjeeling district and very probably from Dibrugarh and the surrounding tea-area where some of the best tea-seed is grown. It is possible that the blight may have been introduced with the seed or the earth in which it is usually packed. Though many spotted leaves from weeds and trees among the tea bushes and on the edge of the jungle were examined none were found to have been caused by the same fungus (*Exobasidium vexans*) as causes blister-blight on tea. On Kharani (*Symplocos Theæfolia*) a very similar blister occurs caused by an Exobasidium nearly related to that on tea. There are microscopic differences between the two fungi and probably they are different species. Preliminary inoculations made to see if spores from the Kharani blister would attack tea were not successful.

Methods that have been tried for keeping the disease in check resolve themselves into (1) picking off diseased material, (2) pruning, and (3) spraying with fungicides. The first and second aim at lessening the spread of the disease by removing, and

PLATE XIII.



A. J. I. EXOBASIDIUM ON SYMPLOCOS THEÆFOLIA.

destroying the material containing the spores of the parasite which cause new infection. The third aims at killing the fungus and at preventing the growth of spores that may fall on the sprayed leaves.

On Dooteriah Division ever since the blight was first seen the Manager had the blistered leaves picked off and destroyed, and it was hoped that this would have been enough to keep the disease in check. The coolies who picked the blistered leaves were not allowed to pick leaf for tea and the baskets were kept separate. The diseased leaf was burned in the factory furnace when the coolies happened to be within reach, otherwise it was buried in trenches. This saved the risk of infection while the baskets were being carried long distances through the tea or sent down the wire rope. The tea near these trenches did not become more affected by the blight than that anywhere else. In all 620 maunds of blistered leaves were destroyed this season, yet in September the blight spread more rapidly than it could be dealt with and got beyond the available labour for treating it in this way. Thus though the blight was kept in check for a time the result was not satisfactory.

The Manager of Pussimbing tried to check the blight by close picking. All blistered leaves, young shoots and sprouting buds were removed whether affected with blister-blight or not, and then the coolies got round the garden once every eight to ten days. They took a bud and two leaves as usual but removed most of the third leaf as well. The idea was to take all the leaves on which the blight grows before it had time to bring its new spores to maturity. By thus continually preventing the production of spores, it was hoped that, after a time the young shoots would grow up free from blight. So far as the absence of blister-blight is concerned, the result on Pussimbing and especially on Pubong was very satisfactory. In July blight was prevalent on both gardens and severe on part of the latter, but by the middle of September there was not much blight on either.

The drawback planters urge against this method is that it takes a strong labour force to pick over a garden in the time

and in most gardens in the Darjeeling district at the present time this is said not to be available in the busy season. If a garden was in vigorous health and flushing well, it could not be overtaken in time, for even with the ordinary way of picking it is sometimes difficult to get round. Then, again, this method of close picking is practicable only in the latter part of the season after good growth has been made in the earlier part of the year, but would be dangerous after a period of unfavourable growth at the opening of the growing season. Some modification in the style of leaf-picking along the lines of this method seems, however, the most likely way of dealing with the blight in the rains, and the details will have to be worked out by a practical man on the infected gardens.

Spraying.—It was demonstrated at Tukvar in a number of small experiments that spraying with Bordeaux Mixture kills the spores and filaments of the fungus where the liquid comes in contact with them. It also does much good on young green twigs affected with blight. In the usual course of the disease when a twig becomes "blistered" the swelling extends gradually round and through the twig, and ultimately causes the part above the spot to succumb. If, however, it is sprayed before the spot has extended much, then the Bordeaux Mixture kills the fungus and the shoot recovers. This in itself is a great advantage as it saves the buds in the axils of the leaves above the affected spot to produce leaf for tea. The mixture on the leaves also prevents spores that fall on them from developing.

As spore-formation usually and infection invariably takes place on the under-surface of the leaf, this is the side that must be sprayed. That accordingly makes spraying difficult as the tea bushes are very dense. Spraying on tea gardens situated as they are on steep slopes of hill sides is an arduous task. The chief difficulties in the way are due to heavy rainfall and to the difficulty of transporting water for preparing the fungicide. During the time when blister-blight is spreading the heavy and frequent showers wash off any liquid sprayed on the leaves, and

especially on the high gardens, about the mist-zone where it is often continuously wet for days together. The fungicide does not always remain long enough on the leaves to prevent incipient blisters from maturing. It has no effect on new shoots that develop after the application, and they are just as ready to be infected and spraying must be repeated for their benefit. General spraying in the rains is impracticable, but on heavy pruning, new-extension and seed-beds, where the area is small and the blight might cause heavy loss, the labour and expense of repeated spraying would be well repaid by the saving of the plants. At Tukvar a small block of heavy pruning became well blighted in June and July. It was sprayed with Bordeaux Mixture five times, and in September looked very well, though it never became quite free from blight; a few blisters could be found here and there. The bushes were all healthy and had made good growth. The Manager was well satisfied that the result was worth the effort made. Spraying in such cases, to do good must be repeated; once only is not enough. Buds that open after the bush has been sprayed are unprotected by the fungicide, and are liable to fresh infection and have to be covered with fungicide.

Pruning.—It is on pruning that reliance will have to be placed in combating blister-blight during the cold weather. For this one cold weather all bushes should be pruned, in the ordinary way back to the last one or two buds and the lower as well as the upper parts of the bush should receive attention. All prunings or at any rate all from affected areas should be burned or buried, and with careful cultivation following, all the fallen leaves and twigs will be turned in and rendered harmless. Prunings ought by no means to be left on the ground nor is it sufficient, simply to turn them in during cultivation.

As it is possible and very probable that unpruned tea carries over the blight from the end of one season to the beginning of the next, it is strongly to be recommended that this cold weather no tea be left unpruned. Heavy pruned tea suffers severely, and whether the leaves are picked off or left blistered on the bush an attack often means disaster. As little as possible heavy pruning should

be done this autumn, and when it must be done care should be exercised in selecting a plot that it is not very near one that was badly affected. It is necessary that every one should adopt the measures as one neglected garden may infect a whole neighbourhood.

At the beginning of the season of 1910, a careful look-out should be kept for the first appearance of blister-blight and whenever seen the blistered leaves should be destroyed and the surrounding bushes should be sprayed thoroughly with Bordeaux Mixture, and after a day or two a man should be sent round to pick any leaves with fresh blisters that may have escaped treatment. Continue the treatment till the early rains come.

Recommendations for the cold weather of 1909-1910.

It would be desirable

to prune all bushes in the garden. The pruners should open up the bushes and remove all growth-leaf showing traces of having been blistered.

to leave no unpruned tea anywhere on the garden and to do no top-pruning (skiffing).

to do heavy pruning with caution and to restrict the area as far as possible. It should be done comparatively early to get some growth in spring before the blight may appear.

to burn prunings or to bury them in trenches under at least 1½ foot of earth.

to have a responsible assistant go carefully over every block to see that no infected stems or leaves are left on the bushes or exposed on the ground.

to begin pruning early in the cold weather and to cultivate soon afterwards, in order that any blighted leaves or twigs on the ground may be forked in.

Every garden in the whole district should be pruned. Success in exterminating the blight depends on whole-hearted co-operation.

If blister-blight should appear in March pick off blistered leaves at once and spray the surrounding bushes. This may be done till the early rains come.

In seed-beds, new-extension and heavy pruning, where the damage from blister-blight is considerable, be prepared to expend money on repeated application of blight-remedies because the benefit in each case would more than pay for the cost of treatment.

Explanation of Plates.

Plate X (*Frontispiece*).

Tea leaves and stems affected by Blister-Blight.

Plate XI.

Fig. 1. Shoot of a tea showing the upper part bending over at the affected spot on the stem.

Fig. 2. Upper side of a blistered leaf showing the concave spots. From a photograph.

Fig. 3. Under side of a blistered leaf showing the convex spore-covered surface. From a photograph.

Plate XII.

Tea bush affected by Blister-Blight. From a photograph by Mr. Claud Bald, Tukvar. The surrounding bushes have been blocked from the background.

Plate XIII.

Exobasidium on Kharani (*Symplocos Theæfolia*, D. Don.)

A NEW INSECTICIDE.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

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Insecticides do not occupy the same place in this country that they do in other agricultural countries, but they have been increasingly used during the last few years by those who grow the more valuable permanent crops, fruit trees or vegetable crops, and they are a necessity on experimental farms where the results of experiments must not be interfered with by insect pests. A small number of standard insecticides, suited to a tropical climate, have been tested in India, and they have been available and are in use. In this country, however, there are objections to the use of one class of insecticide which is largely employed elsewhere, namely, the arsenical poisons used against caterpillars, grasshoppers and similar leaf-eating insects; these objections are important, and they have been a constant bar to the use of these compounds; the best form of "stomach poison" (*i.e.*, insecticide which poisons the insect eating the leaf) is lead arseniate; it has in America replaced Paris Green, London Purple and the older arsenicals very largely and even in England is now being used. Lead arseniate was introduced to India six years ago, has been made and sold to a considerable extent, and has represented the best available stomach poison. The objections to it are of a peculiar nature; it is first of all an irritant cattle and human poison; its introduction into India generally might lead to complications such as cattle-poisoning, etc., which would be ascribed to its use as an insecticide; it decomposes in this country if kept in paste form, owing partly to the high temperatures; and in decomposing it forms soluble arsenic which poisons the plant at once, it is expensive, its ingredients are not readily obtained

and only one firm in India makes it. Its careless use might lead to cases of cattle-poisoning. Especially in a country where crops are not fenced, where stray cattle abound and where spraying is not a general practice. The mere suggestion of using an arsenical is repugnant to those not accustomed to the use of insecticides, and this has militated against its general use.

Unfortunately there has been nothing to replace it ; lead arseniate is in constant use elsewhere, and neither entomologists nor insecticide manufacturers have found a demand for anything not containing arsenic ; lead arseniate has not the objections elsewhere as it has here, and no other stomach poison known could replace it. This was realised some years ago, and one of the first investigations taken up at Pusa was to find a substitute which had not the objection arsenic has while still being an insecticide.

This inquiry has been in progress for four years ; in order to make it thorough, the work was planned on a wide basis, in the hope of eliciting some guiding principle. Substances of all sorts were tried, mineral compounds, salts, organic compounds, alkalies, etc. ; the work was first done in the insectary on caterpillars in captivity and on one uniform method. A number of caterpillars were kept and fed in confinement ; twenty was the usual number ; the food was dipped in water containing a weighed quantity of the substance under trial, precautions were taken to make this wetting even ; the amount of food was such that nearly all was normally eaten ; *i.e.*, each caterpillar got all it wanted, and between them practically all supplied was eaten daily, so that if the poison was unevenly distributed on the leaf, the parts where it was thicker were eaten as well as the rest, and the average effect was the same. The method is not an entirely accurate one, but is as near accuracy as can be got.

The compounds tested were weighed in molecular proportions equivalent to a standard dose of lead arseniate ; thus taking 1 lb. of lead arseniate in 30 gallons as standard, the other compounds were calculated in molecular proportions, and not in equal weights.

The estimation of poisoning effect was done by observing after how many hours each caterpillar died, if it did die, and taking the weighted mean of the results; thus, if of 20 caterpillars 3 died in 6, 3 in 9, 12 in 12, and 2 in 15 hours; the average period of life after feeding poison was 11 hours; the poisoning ratio was taken then as 11. The lower the figure, the greater the poisoning effect, and for each substance we obtained a definite figure. After a long series had been done, it was found that the compounds fell into four classes: those that killed in 24 hours, those that killed in 24 to 40, those that killed fairly regularly, but with an average figure from 40 to 100, and those that were irregular or without effect. For instance, if we fed Magnesium Carbonate, and out of 20, 15 caterpillars survived 5 days, the average figure becomes some thing over 100, and this compound was rejected, as it was found that usually the caterpillars survived altogether; in any case, caterpillars in 4 days' hard feeding would do damage.

Having got classes I and II defined, the practical necessities of the case were considered; for instance, Iodoform is very deadly, but useless as a field insecticide; we turned to the substances in classes I and II that might be useful, and we found that there were certain substances that might be commercially available; what must such an insecticide be? It must be (a) insoluble in water, or rain washes it off; (b) cheap; (c) stable and not apt to decompose into compounds that poison the leaf.

Eliminating from classes I and II the compounds not fulfilling these conditions, there remained a small number of substances, not of very high killing value, that might be valuable as "deterrents" if not as "insecticides." Thus, a plant sprayed with Copper Sulphide might be so distasteful to caterpillars that they would leave it even if it did not poison them. The commercial possibilities of these were investigated, and it was found some of them were available as dry paints; these were tested, and among them was a particularly effective compound sold as Lemon Chrome; this consists of Gypsum and Lead Chromate in particular proportions to give a lemon yellow tint. Lead Chromate was accordingly tested and gave good results; its poisoning action

was high, and it seemed likely to be a commercial possibility. Up to now all the tests were insectary ones, field tests were then made, first on plants under control with a definite number of caterpillars on, then, as opportunity offered, on crops attacked by caterpillars. On these field tests, it was found that some otherwise suitable compounds injured the plants, and as a result of these tests, all other compounds but Lead Chromate were abandoned. Lead Chromate offers distinct advantages; it is easily made in paste form; it is yellow and can be easily seen on a sprayed plant; it is extremely insoluble; soluble chromates do not poison plants to the extent arsenic does, so even were it to decompose, it would not be injurious; it does not decompose on a leaf; it is not easily washed off; it contains no arsenic. During this year we have applied this compound to a great variety of crops; we have sprayed them till every leaf was yellow; the poison has remained on for over three weeks, thickly on the leaves, which were uninjured; sprayed on to crops attacked by caterpillars, the caterpillars are killed, and the results obtained have been excellent. We have used this at 1 lb. in 32 gallons; at this strength it is entirely safe, poisons caterpillars and acts as a very powerful deterrent.

In protecting plants from caterpillars and grasshoppers there are two things to consider: are you dealing with a caterpillar which feeds specially on that plant, or are you dealing with a grasshopper or beetle which is not restricted to that plant; for the former you must apply an insecticide, a real killing agent, that will poison it, because it can feed on nothing but that plant, and all its instincts are to do so; for the latter, a deterrent is sufficient, because it will leave that sprayed crop and go elsewhere. In certain cases a deterrent is sufficient; in others, especially with caterpillars, you must apply a really deadly compound in small amounts that will actually kill. Lead Chromate has not the poisoning effect of Paris Green for instance, which can be applied at one pound in 200 gallons; but it has a poisoning effect comparable with that of Lead Arseniate and is, in our experience, a perfect substitute.

Lead Chromate is made by dissolving in one lot of water Potassium Bichromate, in another lot of water Lead Acetate or Nitrate. The two solutions are mixed, and a dense yellow precipitate of insoluble Lead Chromate is formed, and Potassium Nitrate or Acetate. The latter is soluble and is readily washed out of the precipitate. We have neglected it and prepared our Lead Chromate by dissolving the lead salt in the spraying machine, dissolving separately the Bichromate and adding the solution to the spraying machine. The figures are as follows :—

66·2 grammes of Lead Nitrate combine with 29·4 grammes of Potassium Bichromate giving 64·6 grammes of Lead Chromate; allowing for impurities, we found that 65·2 grammes of commercial Lead Nitrate combined with 30 grammes of Potassium Bichromate; in practice 2 ounces of Lead Nitrate combine with one ounce of Potassium Bichromate giving two ounces of Lead Chromate; this is the actual amount required for one kerosene tin of water (4 gallons) at full strength or for two kerosene tins of water at the usual strength.

This is the best way to apply it, to mix the two solutions in the spraying machine and then apply it; but the paste can be purchased and arrangements have been made for the sale of this insecticide.

In India, there is a very large field for the use of insecticides, but they are as yet very little known. For many reasons they cannot be applied at present to ordinary field crops; but from experiment farms, from those cultivating valuable crops, fruit trees, or vegetables we get a steady stream of enquiries as to how to check beetles, grasshoppers, caterpillars and similar biting insects. To all of these there is but one answer: apply a stomach poison: now that a non-arsenical stomach poison is available, and that a thoroughly good reliable hand sprayer can be bought at a reasonable price in India, there is no reason why such pests should not be dealt with. At Púsa we have occasion to use stomach poisons constantly; against all insects that injure crops by biting the leaves, we use Lead Chromate and we can

use no other method that is equally effective and cheap. The discovery of a substitute for arsenic removes one objection to this method of treatment, and we believe that there is no reason why the use of this insecticide should not entirely remove the losses experienced from this class of pest on the more valuable crops and on experiment farms. There is at present no commercial agency that advertises and pushes the sale of insecticides and machines, but we have arranged for the sale of this insecticide and will give particulars on application.

CATTLE-BREEDING IN SIND.

By G. S. HENDERSON, N.D.A., N.D.D.,

Deputy Director of Agriculture, Sind, Mirpurkhas.

Present Condition of Cattle.—Looking generally to this in the light of experience gained by touring through most of the representative tracts of Sind, the whole country might be classed for the purpose in view as follows :—

1. Karachi and West non-alluvial country.

2. *Thar* or desert portion extending from Runn of Cutch north to Ghotki and Mirpur Mathelo *talukas* and to the east of the Nara.

3. Lower irrigated Sind including all the south alluvial land from the Runn of Cutch.

4. Upper Sind.

These divisions are useful, as the general conditions of cattle stock in each individual division are similar, but the divisions vary from each other considerably.

2. *Karachi.*—This is the only part of Sind where cattle-breeding as distinct from cattle-keeping can properly be said to exist. The country round Karachi is non-alluvial with prominent stony hills of lime-stone out-cropping. The rainfall is small, and apart from the valleys, there is little cultivation, and that very scattered. Cattle-breeding is carried on here chiefly with the object of supplying the Karachi market with milk. When too far from Karachi, *ghee* is made. A number of the cattle owners are not zemindars and wander about considerably. The principles of breeding are clearly understood ; the cattle are carefully bred ; and the advantages of breeding from bulls descended from a milky strain are clearly recognised. An excellent type of dairy cow has thus been evolved. The cows when in milk get

8 to 10 lbs. per day of concentrated foods, and in some instances, are said to yield 30 lbs. or 3 gallons of milk per day, an excellent result, and a yield which would shame no highly bred dairy cow in England. They are exceedingly hardy and have a large run of pasturage, though on little of the land could any fodder crops be grown. It is from the cattle round Karachi that Sind has got its name of being an excellent milk cow. A number has been exported from Karachi to various parts of the world, and is favourably spoken of in Ceylon and Straits Settlements. So in this district, any lines of improvement adopted must be in the direction of milk production. Working capacity is a secondary consideration.

3. *Thar or Desert.*—The chief natural feature of this country is parallel ranges of sand hills piled up by the prevailing winds and more or less covered by spurs and typical desert vegetation. The "bhitts" or ridges run from north-west to south-east and are often ¼ mile broad and over 200 feet high from crest to trough. Some cultivation is done in years of good rainfall between ridges where the rainfall gathers. The villages are very scattered, but each village owns a big herd of cattle, and in the south, buffaloes. The cattle are all mixed together, and bull-calves are seldom castrated. Pasturage is, as a rule, plentiful, specially after the rains. The number of cattle kept depends on the supply of water available. Tanks and wells are often 10 miles or more apart. If the rains are defective, the cattle are often brought up the Nara Valley. On the Runn itself large herds of buffaloes are grazed. *Ghee* is the great export, and little else is carried from the desert stations of the Jodhpur-Bikanir Railway. The cattle here generally show admixture of Marwar or Cutch blood. Light gray is the prevailing colour; they are generally bigger and longer in the leg than the typical Sindi with finer head and longer horns. As a rule, the cows are not nearly such heavy milkers as the Karachi ones, nor are they so well fed or cared for.

4. *Lower Sind.*—The cattle, on the whole, are distinctly good, and quite suitable for the country. There is a distinct

tendency towards deterioration in Upper Hyderabad, where the system of irrigation is mostly "lift." When the Indus is in flood, the inundation canals are filled, and water is lifted from these by Persian wheels or "hurlas." On lower ground towards the tails of these canals 'flow' irrigation is obtained, and rice is generally cultivated. On the lift land, the cattle get harder work, and the natural grass gets dried up sooner. On the rice land in Lar and along the Nara Valley generally the cattle are of as good a type as could be desired under the circumstances. They are a good size, strong and both useful milkers and workers. They are very hardy and have remarkable powers of recuperation from periods of scarcity. There seems to be no scarcity in numbers; on the contrary, on the Mithrao Canal, hundreds of cattle can be seen watering every few miles, each herd the property of the neighbouring village. Also in Lar in the middle of the hot weather, large numbers of cattle may be met coming up from the low rice lands to escape mosquitoes and flies. On the Jamrao area the cattle are more mixed in type, and there are many villages with very poor cattle, this land being more recently settled. Some colonists brought their cattle with them from the Punjab, and a few imported cattle from Marwar.

5. *Upper Sind.*—The cattle in Upper Sind and specially in Sukkur are in great contrast to those generally found in Lower Sind. They are all round of similar type, but are very considerably smaller and weaker. Indeed, it is almost impossible to introduce any improved agricultural implement into this district without getting it first specially lightened. The cattle have constant work here, and there is great need for the introduction of a bigger and heavier, but still hardy, type. Selected specimens of Lower Sind cattle would do admirably. There is much "bosi" and "sailabi" cultivation, *i.e.*, flooding the land on the rise of the Indus, and thereafter keeping the land constantly ploughed to prevent evaporation till *rabi* crops are sown in October and November. Also much of the *kharif* cultivation is left, so the importance of good work cattle is obvious. The type

of country cart depends greatly on the cattle available. In Lower Sind where the roads are not absolutely impracticable for wheeled traffic, the carts used are strong, well-built and iron tyred. In Upper Sind, the *ghary* is very *kutcha* with solid wooden wheels and wooden axle, and drawn by "bails" not much bigger than good-sized donkeys. This point is important as the Army Supply and Transport Department only register iron-tyred *gharies* for mobilisation purposes.

6. *Feeding.*—Strictly speaking, there is really no system of common pasturage in Sind, except perhaps in the desert. Owing to the fallow system where a cultivator will only take a crop off $\frac{1}{4}$ of his holding in one season, there is always a large area to run his cattle on. In Lower Sind especially when, as in the last few years, the rainfall has been over 10″, the waste land gives a certain amount of natural herbage. In Upper Sind, the rainfall is much less, and the natural grass correspondingly less. Where more intensive cultivation is adopted, fodder crops will have to be grown, and these pulses and clover will not only supply constant and nutritious feeding, but immensely enrich the soil. In fact, a solution of the whole problem would follow naturally the change of the present irrigation system, *i.e.*, new perennial canals designed to water all the land commanded by them. At present, the water in the canals is not sufficient to grow fodder crops, and all available water is given to food crops and cotton. It has been suggested that the waste lands might be flooded occasionally to encourage natural grass, but this could only be done at the expense of main crops. Pulses grow exceedingly well in Sind, and all the common Presidency pulses have been successfully cultivated at Mirpurkhas. *Berseem* or Egyptian clover—*facile princeps* of fodder crops—flourishes exceedingly. *Choula* or Cow Pea, *Mathki*, *Mung*, *Muttar*, *Kulthi*, *Choura*, *Lang* and gram all do well, so there is no lack of material to work on.

7. *Natural Herbage in Sind.*—These lists are by no means complete. The vernacular names with their English botanical equivalents are given below.

Grasses eaten by stock and mostly found in dry land are :—

1. *Soreari.* *Eragrostis minor, Hast.*
2. *Gandhir.* *Eleusine flagellifera, Nees.*
3. *Modise.* *Cyperus conglomeratus, Rottb.*
4. *Tope.* *Eragrostis ciliaris, Link*
5. *Baruoo* (good fodder). *Andropogon halepensis, Brot.*
6. *Mandhanu.* *Eleusine aristata, Ehrenb.*
7. *Gum.* *Panicum turgidum, Forsk.*
8. *Saen.* *Elionurus hirsutus* (commonest grass in desert).

9*a*. *Bhurt* (1st kind). *Pennisetum orientale, Rich.*

9*b* *Bhurt* (2nd kind). *Cenchrus catharticus, Del.*

10 *Daman.* *Pennisetum cenchroides, Rich.*

Also the followi g which are found generally all over Sind and especially in irrigated land.

11. *Chubber* or *Hariali* or *Doub* with *Punjabis.* *Cynodon dactylon, Pers.*
12. *Khey* (best natural fodder grass when young).
13. *Puttar.*
14. *Muckane.*
15. *Dirce.*
16. *Dub* (*not Doub*).
17. *Kul* (in wet land ; slightly eaten by goats when young).
18. *Kanh* (coarse, rough grass).
19. *Savri.*

Plants which serve as fodder for stock in the desert and Sind generally :—

1. *Backar.* *Indigofera cordifolia, Heyne.*
2. *Khirol Dodho.* *Euphorbia clarkeana, Hook. f.*
3. *Hadia Kharar.* *Corchorus tridens, Linn.*
4. *Buh.* *Ærua javanica, Juss.*
5. *Janalley* (1st kind). *Polygala irregularis, Boiss.*

5*a*. *Janalley* (2nd kind). *Farsetia Jacquemontii, Hook. f. and T.*

6. *Rihan.* *Polycarpæa corymbosa, Lamk.*
7. *Ridhan.*
8. *Vudha.* *Indigofera linifolia, Retz.*
9. *Yaduck.* *Anticharis linearis, Hochst.*
10. *Chug.* *Crotalaria burhia, Ham.*
11. *Tooh.* *Citrullus colocynthus, Schrad.*
12. *Bisooni* (camels). *Tephrosia apollinea, Link.*
13. *Golaro.* *Cephelandra indica, Naud.*
14. *Sounar.* *Boerhaavia diffussa, Linn.*
15. *Kakora?* *Melothria madraspatana, Cogniaux,*
16. *Usci.* (Camels and goats). *Heliotropium ophioglossum Stocks.*
17. *Khasan.* *Heliotropium tuberculosum, Boiss.*
18. *Mungari* *Phaseolus trilobus, Ait.*
19. *Uckru.* *Melothria madraspatana, Cogniaux.*

20. *Suntar.*
21. *Dhukri* (Camels). *Indigofera trigonelloides, Janb. and Spach.*
22. *Mungasar. Polygala irregularis, Boiss.*
23. *Waho* (Camels). *Trianthema pentandra, Linn.*
24. *Jar. Salvadora oleoides, Dcne.*
25. *Vungri. Lepidagathis Sp.*

Shrubs eaten by Stock :—

1. Kiar chiefly browsed by goats.
2. Jar.
3. Kamboon.
4. Khabar specially eaten by camels. There is a sweet and a bitter variety.
5. Jhil.
6. Ikar.
7. Booh.
8. Lai eaten by camels.
9. Lani from which is made 'khar' or alkali.
10. Damaho.
11. Khiro.
12. Gandhier.
13. Lular.
14. Kandero, thorny bush.

Trees on which stock sometime browse :—

1. Babuls.
2. Kunda.
3. Bair.

8. *Breeding.*—As all the cattle run together, and young bulls are not usually castrated, it follows that the system of keeping a few bulls at stud would serve no useful purpose. In Lower Sind, there are already a number of excellent bulls, and if only the cattle owners would prevent their cows from breeding too early, an age say under 3 years, they might very well be left alone.

9. *Suggested Methods of Improvement:* (1) *Shows.*—If shows are properly organised and systematically held, I think they would serve a useful purpose. The number should not, however, be too great. It is convenient to combine a show with some local fair, as there is then no difficulty in collecting a good attendance of visitors. For example :—

(*a*). Shikarpur (not Jacobabad which is essentially a horse fair, and the same visitors go to both, as they are not far apart) for Upper Sind ;

(*b*). Sehwan for Larkana ;

(*c*). Talhar for Hyderabad 'Lar ;'

(*d*). Pithoro for the Nara Valley and the Thar ;

and possibly one for Karachi. The classes should be much more general and should include milking competitions, also classes for groups of young cattle the property of one village. Along with this, prizes should be given for the various local kinds of agricultural produce, and the occasion would be an advantageous one for demonstration and exhibits of the Agricultural Department. A specimen programme is given below.

Suggested Programme for Talhar Show (Cattle Classes) :—

1. Sindhi cow in calf or calf at foot 1
2. Sindhi bull or bullock 2
3. Other breeds, males, including buffaloes 3
4. Buffalo cow or heifer 4
5. Most thriving lot of young stock not less than four, under one year, male or female, cow or buffalo and property of one village 5
6. Pair 'bails' in *ghary* 6
7. Milking competitions, highest yield in two milkings, morning and evening.

Cow	*Boná fide* property of	'hari'	7
	Do.	'zemindar'	8
Buffalo	Do.	'hari'	9
	Do.	'zemindar'	10

8. *Hurla* competition. For greatest number of turns of a 'hurla' in ¼ of an hour. Drivers not to use sticks and to stand 3 yards away 11
9. Sweepstake Competition for best animal in show. Entry fee Re. 1 ; judging to be done on points ; winner to get total entry money 12

10. (2) *Establishment of Dairy Herd of Sindhi Cattle.*—This method would, no doubt, entail a considerable initial expense, but would be invaluable in finding out what Karachi cattle are capable of. Hyderabad would be a good centre for starting, and the Local Fund Garden (about 100 acres along with some rough pasturage) would be a suitable position for erecting the dairy. The young stock could be easily distributed among dairy men, and if up-to-date plant was used for butter making and milk sterilisation, the dairy ought to pay its way. In

this connection, experiments could be carried out with the Jersey-Sindhi cows. I am aware that Mr. Mollison is averse to the introduction of foreign blood in India, but as these crosses would only be given to *boná fide* dairymen, this would perhaps not come under his objection.

11. (3) *Importing bigger Bulls into Sukkur District.*—There seems to be a demand for better cattle in Sukkur District, but land-owners do not seem inclined to go to the trouble of travelling about to pick up better ones. As usual if anything has to be done, Government must step in. I would suggest that the leading zemindars in Sukkur District (for a start) be personally approached and asked if they will each take one good sized Lower Sind bull at cost price, which price will include cost in Lower Sind plus expenses of transit, etc. Arrangements could be made to buy these in 'Lar' or the Nara. If 100 good bulls could be brought into Sukkur, the effect would be bound to be quickly marked. A concession might be obtained from the North-Western Railway, if a fair number were sent at the same time. It is true that this does not do away with the feeding difficulty, but a good Sindh bull will stand a considerable amount of bad treatment, and it is very important to introduce a bigger type of work cattle.

12. Lastly, while buying for Sukkur Experimental Farm, notice was sent round to the cultivators on some of the inundation canals in Mirpurkhas. They brought some 50 or 60 cattle of all sizes and ages and some good bulls were got at prices ranging from Rs. 40 to Rs. 90 each. These improved considerably after good feeding, and a zemindar in Sukkur offered Rs. 90 for a bullock bought a short time before at Rs. 40.

13. (4) *Providing Drinking Water in the Desert.*—It would probably be found possible to store water in the Thar by digging tanks between *bhitts* in suitable situations. The trough between a pair of *bhitts* forms a good catchment area, and a small deep tank would store a considerable amount of water. The expense of digging these would be small. It is simply a question of water-supply at present, as the natural desert forage is useless

except within reach of drinking water. Even if the water supply did not last all the year round a considerably increased number of live stock could be supported. It is certainly worth the trouble and expense of making a few trial tanks in selected localities.

COMPETITION OF CULTIVATORS FOR CHECKING THE STEM-BORER OF SESAMUM.

By CHOTABHAI U. PATEL,

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The chief aim of Entomological Assistants working in different parts of India, is to bring the methods of dealing with crop pests, within the reach of cultivators. Series of efforts made during the last four years, to attain this end by means of leaflets and lectures, have failed in producing substantial results in this part of Gujarat (Baroda territory). I do not wish to trouble the reader with the many reasons for this disappointment, but it will suffice to mention that the Gujarat cultivator requires to be convinced of the successful effects of any suggestion, personally and practically, before he can be made to follow it. I am of opinion that if two or three of them are specially urged to make a beginning in giving effect to a suggestion in each village, and are convinced of the utility of the work, by pointing out the resulting benefit, it is very likely that others will be tempted to imitate them without hesitation. During the last rainy season, I had made an effort in Baroda State to induce a few cultivators of different villages to follow my suggestions for fighting against the stem-borer of sesamum, in which I have been successful. I, therefore, propose to describe the organisation and management of the affair in this article.

Before entering into this description, it is necessary that I should give at least as much information of the insect as is required for practical purposes. It belongs to the genus *Oberea* of the family *Cerambicidæ* or Longicorn beetles. The beetle is a little less than half an inch in length; as also are the

antennæ. The colour of the elytra is blackish, and the head, thorax and abdomen are buff coloured. In this stage of its life, it is very active and remains under the leaves, but sometimes the movements of its antennæ reveal its presence. It makes its first appearance in July or August, when the sesamum plants are about six weeks old. All the beetles, likely to emerge for multiplication, finish their work in about a month or six weeks. The female lays her eggs singly, one on each leaf. It is laid near the mid-rib on the under-surface of the leaf. The yellow grub that hatches out, tunnels into the mid-rib and makes its way into the stem through the petiole. Its existence in the leaf can be detected by one or all of the following symptoms :—

1. The leaf is curled down or withered.
2. An irregular yellow stripe is seen on the upper surface of the leaf, near the mid-rib.
3. A part or whole of the leaf is seen dried up.
4. A bulb is formed where the petiole joins the blade.
5. In some cases the mid-rib on the under-surface, and the whole petiole are very much swollen.

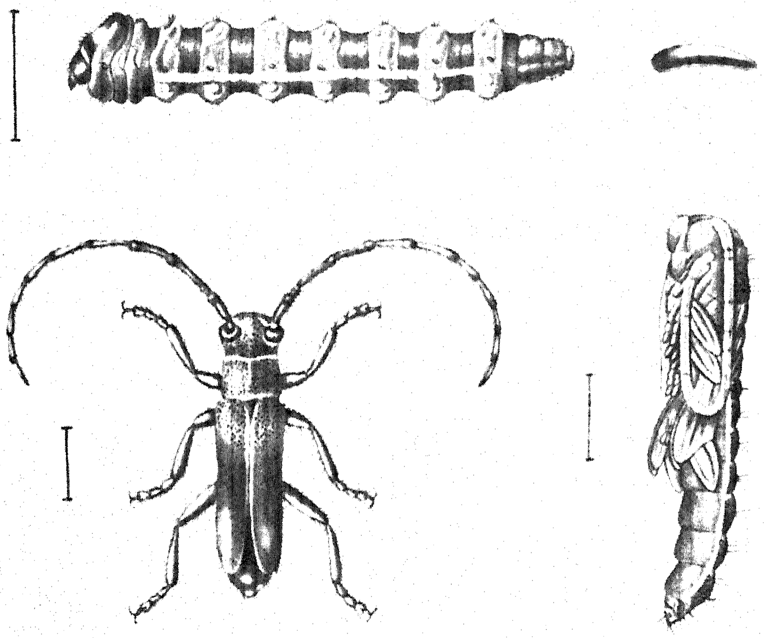
In ten to fifteen days after the second symptom appears, the grub reaches the stem where it is safe from all traps. After getting into the stem it bores its way up and down, till it reaches the downmost end of the main root, where it hibernates till next July. When the leaf, through which it enters the stem, falls off, it tunnels into the petiole of another leaf from the stem. Presumably it does so for respiration. A full-grown larva is about an inch and a half long. The colour of the body is yellow. The thorax is very much swollen. Although it looks motionless when taken out of its residence, it is very active inside. After the harvest of the crop, it seals the top of the stump with the chewed wood and safely hibernates inside. In the middle of June I had examined thirty-five stumps so attacked, of which only two had been destroyed by white-ants. From this I am inclined to suppose that the stumps, which harbour or had once harboured these grubs, are immune from the attack of white-ants which leave no other stump untouched.

From the information noted above, one can easily understand that the ravages of the insect can be successfully checked by removing the affected leaves before it enters the stem, where it becomes uncontrollable. If the cultivator repeats this thrice, at intervals of ten to twelve days after the insect makes its first appearance, his valuable crop is saved. In order to start this method with the cultivators, the following arrangements were made. During the second fortnight of May, meetings were held at different places to raise a force of followers (cultivators). The following statement shows the attendance and selection of cultivators at different places :—

Serial No.	Name of the place of meeting.	Attendance.		No. of followers selected.	Remarks.
		No. of villages.	No. of cultivators.		
	I.—Petlad Taluka.				
1	Petlad	3	30	6	Two were selected for each village.
2	Boria	1	10	2	
	Total ...	4	40	8	
	II.—Baroda Taluka.				
1	Baroda	2	15	4	Ditto ditto.
2	Sameala	1	20	2	
3	Bajna	1	10	2	
	Total ...	4	45	8	

After explaining the life-history and method of treatment of the insect to them, they were given to understand that the one who stood first among the eight of his taluka, in carrying out my instructions, was to get a prize of Rs. 25. In spite of this temptation, it was a very difficult task to raise this force; not because they considered the work to be a difficult one, but because they are accustomed to look at the movements of Government officers with an eye of suspicion from which our efforts are not exempt. In this state of affairs, the success of taking them into confidence is solely dependent on the organizer's knowledge of their habits, as it is the only guide in dealing with these conservative people.

In the middle of June, when the monsoon set in, all the sixteen cultivators were reminded to sow sesamum in an area of half a *bigha* each, and the different dates of sowing each plot were recorded in my office. I had also sown a plot at my head-quarters for reference. In the latter part of July when I saw the first beetle in the reference plot, I went round all the plots of the cultivators. A quarter *bigha* plot was fixed by measurement for each to work, the other half being reserved for comparing the



THE TIL STEM BEETLE. ON THE RIGHT THE EGG AND CHRYSALIS, ON THE LEFT THE GRUB AND BEETLE, MAGNIFIED.

result of treatment. In this trip of mine they were made familiar with the symptoms of the insect's existence, by object-lesson specimens, so that they could promptly execute my instructions on intimation.

The real work began on the first and successive dates of August. The working day fixed for each cultivator was arranged in such a way as to permit my personal inspection of the work next day, and at the same time the interval between two

cuttings should not exceed twelve or thirteen days. The work was finished in three cuttings. In order to avoid friction in the programme, each cultivator was reminded of his working day on the previous day, and in this reminder he was also told to be present in his field on the day of my inspection, when he had to be given practical training. All the three cuttings had been thus managed, and I had no difficulty whatsoever in carrying out my programme. The appended statement shows the details of the work done by the cultivators together with the results.

The comparison of the plants that were killed by the insect in both the plots had convinced them of the result of their work to such an extent that they did not even care to compare the outturn. I believe I have embodied sufficient information in this statement to draw conclusions independently, and hence I need not trouble the reader with the comments on it.

This being done, I had to distribute the competition prizes. According to the original arrangement, only two prizes of Rs. 25 each had to be given to the first of each *taluka*. But with a view to create greater interest in several places instead of two, the idea was changed. It was settled that the one who stood first among the whole lot of his *taluka* was to get Rs. 10, and for the remaining three villages the first of the two of each village was to get Rs. 5. These were distributed at night meetings held at each place for the purpose. The number of audience at different places was 100, 75, 25, 20, 20, 20 and 15. It was a satisfactory number in proportion to the cultivating population of the respective villages. At all these places the audience looked as if they took a keen interest in the talk. The subject of conversation was the practical lesson regarding the origin, growth, damage and destruction of the stem-borer of sesamum. The success in creating interest among them was mainly due to a practical talk being supported by the facts and figures noted from the actual working of their brother cultivators, namely, the competitors. The greater majority of the audience at each place have shown their desire to work up the method next season, but the substantial result of this effort can be calculated from

the number of cultivators who may actually give effect to their desire next season.

In conclusion I may be allowed to suggest that anyone who intends to adopt this system of working should be very careful in replying to the various queries that are forthcoming from the cultivators, which can only be solved to their satisfaction if the speaker has a thorough knowlege of their habits and real needs. This kind of knowledge can be conveniently acquired by freely mixing with them. He should also keep sufficient presence of mind in dealing with this conservative and uneducated class of people, as the slightest carelessness or mistake in speaking to them is enough to lose their confidence.

Statement showing results in checking Stem-borer of Sesamum.

Serial No. of the plot.	Total No. of diseased leaves throughout the season.	No. of diseased leaves picked out by the cultivator.				Total time engaged of one man for the work.	Percentage of work done.	COMPARATIVE RESULT.				REMARKS.
								Total No. of plants killed by the insect.		Percentage of damage.		
		First cutting.	Second cutting.	Third cutting.	Total.			Treated plot.	Non-treated plot.	Treated plot.	Non-treated plot.	
1	2	3	4	5	6	7	8	9	10	11	12	13
					Baroda	*Taluka.*						
1	2,666	65	264	771	1,100	$12\frac{1}{2}$	41	290	1,188	5	24	
2	3,268	29	216	567	812	10	25	435	1,131	17	45	
3	1,209	25	309	238	572	$5\frac{3}{4}$	47	56	175	3	8	
4	3,292	73	57	43	173	7	5	279	620	3	6	
5	3,250	79	378	169	626	10	19	564	1,892	14	47	
6	1,216	174	142	119	435	$3\frac{3}{4}$	36	154	693	7	33	
7	806	111	64	71	246	12	30	56	238	3	12	
8	1,236	108	86	174	368	14	29	18	70	1	3	
					Petlad	*Taluka.*						
1	3,928	1,074	980	154	2,208	8	55	200	350	6	11	The village which represented plots 3 & 4 was exempt from the attack of stem-borer and the competitors had therefore nothing to do in the matter.
2	2,710	187	440	673	1,300	$6\frac{1}{2}$	48	270	365	4	6	
3	1,768	98	385	270	753	$4\frac{1}{2}$	42	190	420	4	9	
6	3,818	1,320	930	488	2,738	6	72	71	560	1	11	Plot No. 7 failed in growth of the crop, in spite of resowings.
8	1,088	202	67	39	308	3	28	40	300	3	25	

NOTE.—The figures entered in Columns 11 and 12 are exclusive of the loss in outturn sustained by the plants which resisted the attack. If this had been calculated, the difference in percentage would have been still greater.

NOTES.

Entomological Notes—*Eri Silk.*—Large numbers of eggs have been supplied to enquirers from many parts of India during the last six months, and short instructions in English, Hindi and Bengali are sent with them, printed copies of which are available. It is necessary to impress on those who are contemplating a trial of this industry that it is as a cottage industry only that we recommend it at present, where the spinning and weaving can also be done. There is as yet no definite market for raw cocoons; it will not pay to simply grow cocoons and sell them, unless there is a definite market; what we recommend is the rearing of cocoons when castor leaves can be had, and when the climate is suitable, giving out the boiled cocoons for spinning by women and children, giving out the thread to village weavers for weaving into plain *eri* cloth for sale in the bazaars. The spinning is as important as anything else, and if there are not the people to do the spinning, as a spare-time occupation in their own houses, the cultivation of *eri* silk should not be gone in for at all. Where the spinning can be done and a cottage industry is possible, sufficient cocoons for the year should be reared, either all through the year, or else for the nine months of rains and cold weather which are not excessively dry and hot. The cocoons produced by *eri* worms in Gujarat, Baroda and some parts of the Central Provinces are better than Bengal or Assam cocoons; the worm thrives best where there are no *extremes* of dry heat or moist heat.

The market for raw cocoons is being investigated, but it will be some months yet before we can estimate the possibilities of the production of raw cocoons on a large or small scale for sale as raw cocoons.

The Pusa spinning machine is available for sale, we recommend its use where spinning with the *charka* is unknown, or where the spinner will use a treadle machine. In all cases it is worth a trial, the small cost of the machine putting it within the reach of every one.

The Deccan Grasshopper.—For some years past a wingless grasshopper has been increasing in destructiveness in the Deccan; it is now being investigated, and in several districts measures have been taken against it. It is a small grasshopper which never becomes winged; it is a "Surface Grasshopper" living on the surface of the soil and climbing up plants to feed on the leaves or on the flower heads or grain. It is destructive particularly to *juar* and *bajra* and does a great deal of harm if it attacks these when they are coming into ear. The life-history is being worked out in detail, but the rough outline is known; eggs are laid in October-November in the soil, remaining there till the following monsoon, when they hatch. There is thus one brood only a year, and the *rabi* crop is not attacked at all. The insect is active only in the rains and must be destroyed early in the rains before the crops become too tall, if it is to be attacked successfully at all. At present the only method in use is to sweep up the hoppers with bags when the crops are young, but better methods will probably be found when the pest has been thoroughly investigated.

A new Indigo pest in Behar.—During the past season, a new pest has been reported from Java indigo, a plant which has few insect pests as a rule. This is a small caterpillar (*Ypsolophus ochrophanes*, Meyr.), which webs up the leaves at the tip of the young shoot, feeding on them and checking the growth of the plant. The young plants were attacked during August, September and October, and in more than one case a considerable amount of damage was done. The pest is a new one to indigo, but is well known as feeding on lucerne, and other pulses; the moth is a very small brown insect (unlikely to be recognised by anyone but an entomologist), which is common during the rains, its active breeding season being June to October. In the present case only young plants a few inches high have been attacked,

and this form of attack can be averted by later sowings. The pest is one that everyone sowing indigo before October should be on the lookout for, as if taken in time it can be checked. It has probably been widespread in the young Java indigo, but has not been noticed, or the loss has been attributed to some other cause.

The Rice Grasshopper.—For several years, the rice grasshopper has been destructive to paddy in Belgaum, and though some measure of success in dealing with it was obtained, the methods used did not commend themselves to the cultivators who adopted them only for one season and without the co-operation essential to success. A simpler method has been extensively used this year and has been so far successful that the cultivators have taken to it and have cleared their fields of the pest to a very large extent. Formerly large nets were dragged through the crop, sweeping up the grasshoppers ; each net required several men, and the work was very heavy. A modification of the bag method was adopted this year, a rough bag of gunny, with its mouth kept open by bamboos, being dragged through the crop to sweep up the hoppers ; such a bag requires only two men to pull it, while two men go in front on each side to drive the hoppers towards the bag. The work has been so successful that large numbers of hoppers have been brought in by cultivators and buried in pits. During the past season, assistance has been given with providing bags, but this will be discontinued, the landowners subscribing to provide the bags required during the next season.

Tukra Disease in Mulberry.—Bush mulberry in Bengal, grown for rearing silkworms, is commonly attacked by a disease called "Tukra" or "Konkra" ("Curled up"). It is very readily apparent as the leaves curl up, the growing shoot curls round on itself and forms a hard knot, and the affected bushes cease to grow or to yield leaf. Such twisted leaves are also regarded as a cause of Grasserie and Flacherie if fed to worms, and in every way the disease is a serious one.

Up to now the disease has been a mysterious one, suggesting a distinct fungoid or bacterial disease and not fully understood. It has now been shown to be due primarily to the presence

of a mealy bug, the punctures of the mealy bug leading directly to 'curling,' either on account of some irritant injected by the bug, or owing to some other result of its puncture. Further, the disease is not caused by the puncture of at least one other mealy bug on the same plant, whilst the puncture of the mealy bug on cotton, hibiscus and some other plants produces exactly similar effects on those plants.

A plot of mulberry was planted in 1908 from cuttings brought from Berhampur and has remained free from bug and *tukra* to this day; but in July 1909, cuttings from this plot were planted in another field, and in September became infected with bug; *tukra* has now developed, and direct infections of plants in the field show that the presence of the bug produces *tukra* in a few days.

The bug (*Dactylopius nipæ*) is a small pinkish insect, covered in mealy wax, which, when young, runs about the plants and punctures the leaves; when the leaves curl and knot, the bug settles down in shelter there and continues to feed, eventually producing many young ones. The twisted curled shoot presumably supplies shelter and food and is a protection possibly from enemies.

The bug is the prey of ladybird beetles and of another bug *Geocoris tricolor* which feeds upon it. It is, however, not so severely checked by these enemies as not to do damage, and remedies must be adopted against it. There is one effectual and simple remedy which should be enforced as soon as the first *tukra* leaf is seen; every *tukra* leaf and shoot should be plucked, carefully taken from the field and either at once burnt or buried. The present practice of plucking the *tukra* leaves and shoots and dropping them on the field is the worst thing possible; every mealy bug in these shoots comes out, walks up another plant and spreads the disease further. If one wanted to get as much *tukra* as possible, one could not do better than pluck the shoots and leave them on the field. But if the shoots are carefully picked into a basket and at once removed from the field and disposed of, the bug will in time be wiped out. Insecticides are of no

avail in this case, as they do not penetrate the curled up shoots.—(H. M. LEFROY.)

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RICE IN LARKANA DISTRICT IN SIND.—In Larkana district, especially in Kamber *taluka*, rice cultivation has reached a high level. The variety for which the district is famous is "Sugdasi," an excellent quality, white, awnless and delicately scented rice. It seems to have evolved locally, and its cultivation in other rice tracts of Sind has been unsuccessful. There are several forms of "Sugdasi;" they all require careful treatment and the best land. "Suthri," a variety which ripens 60 days after transplanting, is also grown extensively, especially where the land is poorer, or where the water-supply from the irrigated canal is either late or small in quantity. On the bad "Kalar" or alkali lands a coarse red variety known as "Lari," originally from Lower Sind, is generally grown. It is much hardier than either of the other two.

Land with a water-supply suitable for rice is permanently kept for this crop, and it is cultivated year after year without fallowing. These lands depend on their fertility first on growing *mutter*, gram and other pulses in *rabi* after rice, and secondly, on the silt deposited on the land from the irrigated water. The pulse seed is broadcasted in the standing rice shortly before ripening, and after the cutting of the crop the pulse receives no more irrigation water. The system is excellent and quite unknown in Lower Sind.

All rice is transplanted from beds which are carefully cultivated and 'rabbed' by burning rice straw and farmyard manure, etc. One *guntha* beds (1/40 acre) of seedlings is generally said to be sufficient to sow an acre.

The irrigation canals in this district are purely inundation and flow only during the Indus flood, beginning, say, at the end of June and drying up in October. They must deliver a large quantity of silt on the rice lands yearly, as very heavy annual clearances are necessary, and the high spill banks are a feature of the landscape. From the time of first irrigation the rice field

is kept continually under water with a depth up to 1 foot and on no account allowed to dry even for a few days.

The yields per acre are very high. First class "Sugdasi" will give 2 "Kharar" or over 3,000 lbs. per acre of unhusked rice.

The reason why cultivation is so superior in this district is probably on account of the pressure of population which is much denser than in other districts. One "hari" and his family will cultivate about 8 acres of rice, as compared with 30 to 40 acres in other parts of Sind.

Want of labour at harvest is always a difficulty, and during the present season demonstrations have been held in the chief centres with harvesting machinery. The rice is first cut by a manual reaping machine, then removed to the threshing floor and threshed by the 'Norag', and the resulting grain cleaned and delivered ready for market by a winnowing machine. These operations can be carried out simultaneously, and the result is a great saving of time and labour, as in the ordinary way a cultivator may have to wait weeks for a breeze for winnowing the grain. The reaping machine will cut from 4 to 5 acres per day—an acre which would require from 20 to 25 ordinary labourers.—(G. S. HENDERSON.)

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A PROMISING WEED.—The want of green fodder during the dry weather is keenly felt in parts of the Central Provinces and Berar. From December to June grass is conspicuous by its absence. In Chhattisgarh where the staple crop is rice, almost the only fodder available for cattle during this period is rice straw. The present degenerated state of the diminutive Chhattisgarh breed of cattle is no doubt largely due to poor feeding. The introduction of a good *rabi* fodder crop has been suggested as one of the possible ways of improving this breed. A bulky leguminous crop that could be grown after rice would, if palatable as a fodder, exactly meet the wants of this large division. A good deal of attention has, therefore, been given to the study of leguminous weeds with the view of securing one that would meet these requirements. Two years ago one was discovered

growing on a rice plot on the Telinkheri Farm, which on further investigation has proved to be a most promising fodder plant. This weed is *Melilotus alba* and has been designated wild lucerne owing to its close resemblance to cultivated lucerne. It germinates early in November, grows to a height of about three feet, and is relished both by horses and cattle. It was grown as a *rabi* crop on the Telinkheri Farm this year, and bundles of it were supplied daily to Government Officers in Nagpur as a green fodder for their horses ; it was also much relished by the farm bullocks. Major Baldrey, F.R.C.V.S., D.V.H., F.R.G.S., Superintendent, Civil Veterinary Department, who used it for his horses this year, described it as follows :—" I thought *Melilotus alba* an excellent thing as a green fodder. It should be pushed, I think, in the new irrigated tracts."

As a green manure, too, it will, I believe, prove to be of great use to the cultivator of the rice tract, who at present applies the ashes of his cattle manure to the plots adjoining the village, while his more remote rice fields are cropped continuously without manure. Its manurial value has not yet been thoroughly tested, but it has been observed that the rice crop this year was much better in the plots in which a previous crop of wild lucerne had been ploughed in.

Melilotus alba is a biennial. When once established in a rice field, it sows itself and, therefore, requires no further attention. The seed lies dormant in the soil till about the first of November, germinating about the time the paddy is being harvested. To get it established, the seed should be sown among the standing rice towards the end of October at the rate of 20 lbs per acre. The soil being still moist at this time, the seed is trampled in by the feet of the coolies employed in reaping the rice. This method of sowing is well understood in the rice tract of these Provinces, as this is the method commonly adopted of growing a second crop (*utera*) after rice. When grown for fodder, it continues to yield a valuable supply of green fodder from January till March. It requires no irrigation if grown on rice lands which are fairly retentive of moisture.

Being a hardy plant with the luxuriant and persistent habits of a weed, it can be grown with a minimum amount of attention. As a fodder it should prove useful in the dry season when the cattle of most of the rice tracts are dieting on a scanty allowance of unnutritious rice straw. The ease with which it is cultivated will be in favour of its introduction. It is being tried this year as a second crop after rice in several villages of Chhattisgarh. Mr. Dewar, Deputy Commissioner of Balaghat, who tried it last season, speaks of it as having proved a godsend to him during the dry weather, when no other form of green fodder was available for his horses.—(D. Clouston.)

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Agricultural and Industrial Exhibition, Allahabad, December 1910, Agricultural Court.*—It is hoped that this court will contain an economic collection of agricultural exhibits which will interest not only the producer but also the consumer and the manufacturer of finished articles from raw products.

The court will be under the management of the Agricultural Department, but it is hoped that the departmental exhibits will form only a very small proportion of the whole, and every effort is being made to secure exhibits from outside on the largest possible scale.

The attached scheme will show the general lines on which it will be run, but any suitable exhibits not specifically included in the scheme will be accepted, and arrangements will be made to place intending exhibitors in correspondence with the heads of other courts where their exhibits do not fall within the scope of this section. One of the main features of the agricultural court, as of the whole exhibition, will be machinery in motion and working processes. Exhibits of this nature are specially invited and every facility will be afforded for showing manufacturing processes at work. A special pamphlet on agricultural machinery in Northern India may be obtained by manufacturers or their agents on application.

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* All communications concerning the Agricultural Court should be addressed to the Deputy Director of Agriculture, Central Circle, Cawnpore, and covers marked "Exhibition."

Scheme (subject to possible modifications in detail to meet the needs of large exhibitors).

I.—Aids to Production.

1. *Seeds.*—Pure and impure seed, and methods of storage.

2. *Manures.*

3. *Cattle.*—A cattle show will probably be held during a part of the exhibition, and it is hoped to arrange for the presence throughout the whole or part of the time of some of the typical cattle of the province. The co-operation of landholders and other gentlemen, of associations and of local committees is particularly invited. Suitable awards will be arranged for.

4. *Waterlifts.*—For irrigation purposes.

It is hoped to show a complete *working* collection of the various waterlifts in use in the province and also a number of improved lifts for hand, bullock and engine power.

5. *Tillage implements.*—This section will include tillage implements of all types, both Indian and imported. Arrangements will be made to show as many as possible at work.

II.—*Products and their Utilisation.*

It is intended that displays of produce should be select rather than comprehensive. Raw and finished products will be shown side by side with the working process of manufacture. Exhibits of working processes are specially invited, as are also selected exhibits of products raw or finished. Exhibitors of working processes will, it is hoped, arrange for their own power supply but where necessary this will be arranged for from the central power station.

Where exhibitors of machinery are unable to personally arrange for its working, the department will do so if desired and will in every case be happy to assist in providing for a suitable supply of raw material.

Details as to the size of produce exhibits desired will be furnished later.

The following list will show the *approximate* scope of this section. The agricultural court will *not* include general exhibits

of food and drink where the manufacturing process is not exhibited. These will be arranged for elsewhere :—

Rice.—

(*a*) Typical samples of Paddy (threshed and unthreshed).
(*b*) Rice hulling.
(*c*) Samples of hulled rice.
(*d*) Rice starch-making.

Wheat.—

(*a*) Samples of wheat. (Sheaves, ears, bhusa, grain).
(*b*) Flour mills at work.
(*c*) Samples of flour and "ata".
(*d*) Vermicelli and macaroni-making, with samples of produce.
(*e*) Biscuit-making.

Maize.—

(*a*) Cobs and grain.
(*b*) Hulling.
(*c*) Grinding cobs for cattle food.
(*d*) Grinding maize meal.

Gram.—

Samples of grain and meal.
Gram crushers.
Oats.—(Under cattle food).

Oil seeds.—

Samples of oil seeds.
Oil-mills at work.
Oil-cakes and oil.
Linseed, rape seed, til, castor, cotton, dhuan, safflower, poppy, mahua, groundnut.

Sugarcane.—

(*a*) Samples of good varieties.
(*b*) Different methods of preparation of sugar and gur.
(*c*) Sweetmeat-making (Indian and European).
(*d*) Cane mills of different types :—Competitive trials.
(Arrangements will be made for a supply of cane).

Cotton.—

Samples of seed cotton and lint with growing plants of different varieties.

Cotton ginning and baling.

Cotton seed oil manufacture.

Other Fibres.—

Sample of fibres such as :—Sann hemp (Sanai).

Roselle hemp (Patsan).

Bhabar grass.

Munj grass.

Agave.

Ak Floss.

Etc., etc.

Exhibits of decorticating machines at work. Exhibits of manufactured goods.

Tobacco.—

Exhibits of raw produce and of manufactured tobacco. Cigar and cigarette manufacture.

Spices.—

A representative collection of the spices of the Provinces.

Fruits.—

Exhibits of fruits in season.

Vegetables.—

A fruit and vegetable show will be arranged for during the exhibition if sufficient exhibits offer.

Dairy.—

Arrangements are being made to exhibit a working dairy. Exhibits of dairy machinery are invited.

Miscellaneous Food Products.—

Horse and Cattle Food.—

Fodders and fodder cutters.

Silos and ensilage.

Oil-cakes.

Oats and gram-crushing machines.

Maize-cobs mills, etc., etc.

The Department will also arrange for a number of interesting scientific exhibits.

III.—Exhibits of produce by Private Exhibitors.

While it is not proposed to make an exhaustive collection of agricultural produce for section II, it is hoped that a large number of exhibits will be received from landholders' associations and others illustrating the numerous and varied crops of the province.

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A LABOUR-SAVING ATTACHMENT FOR HAND-POWER MACHINES.—The Inspector-General of Agriculture, when on tour in Burma in December 1908, was much interested in the method frequently employed by Burmans in working hand-power machines of all kinds by means of a simple attachment. This method, with a slight modification, has been employed on the Mandalay Experimental Farm for a considerable time, in the absence of other motive power, for various purposes, but especially for chaff-cutting; and although the actual efficiency has not yet been tested, it is generally agreed by those who have seen the operation that a considerable saving of labour is effected. A large number of bullocks (over 50) have to be fed on chaffed *jowar*, and to do the work of chaffing by the ordinary handle would require a great deal of heavy daily labour, but by the aid of this simple device a larger machine can be made use of, and the work more rapidly carrie out. At Mandalay an "Albion" (Harrrison McGregor and Co.) three-knife, $10\frac{1}{2}$ inch mouth, four horse-power machine is made use of—a machine too large to work by hand in the ordinary way, and it requires only three men to work it when chaffing *jowar*.

The following notes and sketches may not only be of interest to readers of the journal, but, as the attachment can be made by almost any local blacksmith at a low cost, they may be useful especially to those who have to pay high rates for labour.

Each of the three parts will be described separately, and although it is adaptable to almost any hand-power machine, as it is most generally made use of in connection with the chaff-cutter, we will consider specially an attachment for that machine.

I. A strong wooden frame as shown in sketch, fig. I, is first made, and the chaff-cutter placed upon it and fastened down in

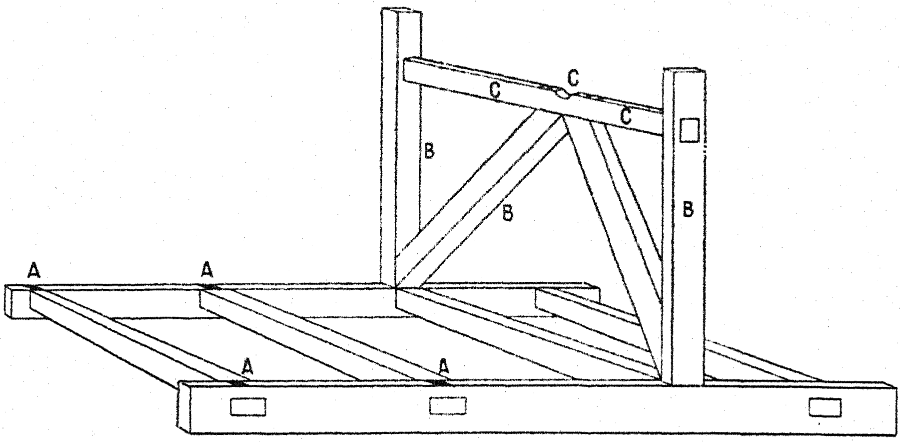

FIG. I.

the positions marked A for the feet. If the machine is a heavy one, it will be unnecessary to fasten it down. The mouth of the chaff-cutter should face towards the support B. The size of the frame depends, of course, upon the machine; and the height of the support B and of the bar C depends upon the height of the fly-wheel shaft.

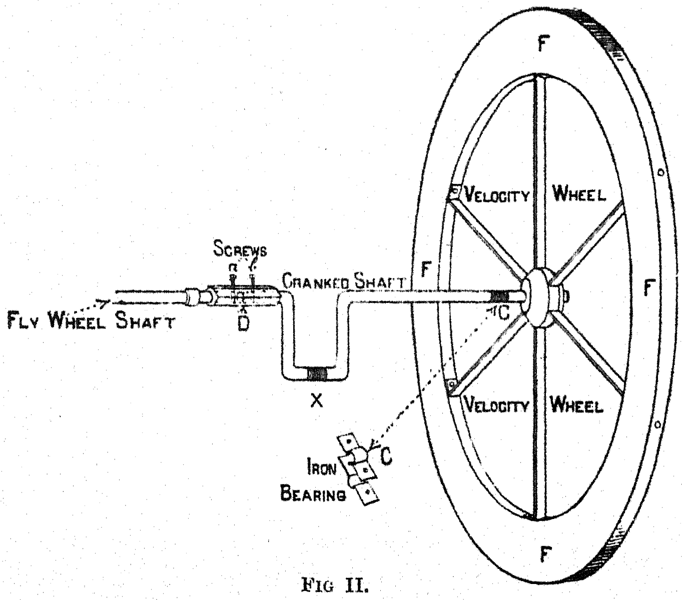

FIG II.

II. The fly-wheel shaft of the chaff-cutter is prolonged as shown in fig. II. This is generally effected by means of a cranked rod of iron, of the same thickness as the fly-wheel shaft, being fastened by means of a double clamp as shown in the figure, or, if the two shafts have flat surfaces, by driving iron "keys" (wedges) beneath the ring or jacket D. In the former method the screws *a* and *b* are sunk into holes in the shafts.

The ring or jacket D is usually made of strong, heavy, cast iron, but other methods of connecting together the two shafts could probably be made to work equally well.

The bearing C corresponds to that on the wooden bar C in fig. I. The large fly-wheel F (or "velocity wheel" as we may call it to distinguish it from the fly-wheel of the machine) is 'keyed' on to the cranked shaft near the bearing C, but so far away that in turning it will clear the support B. This wheel is usually an old cart wheel and is often weighted equally round the circumference. A large heavy wheel is, of course, best as it maintains a more even velocity and carries the motion better past the two points where no work can be applied to the crank X. The cranked shaft is made of any convenient length, but should not be made too long. The length of the crank X is usually from 10 to 12 inches, but it varies in different machines.

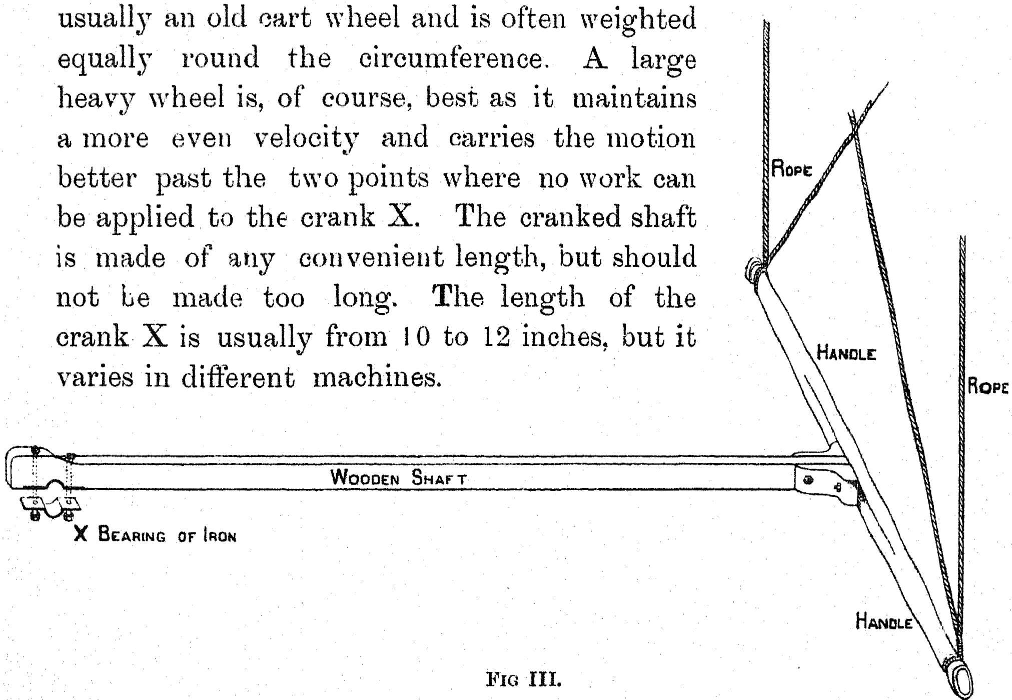

Fig III.

III. To the bearing X (fig. II) is attached a strong wooden shaft about 8 to 10 feet long as shown in fig. III. The method of attachment is also shown in fig. III. A cross-piece

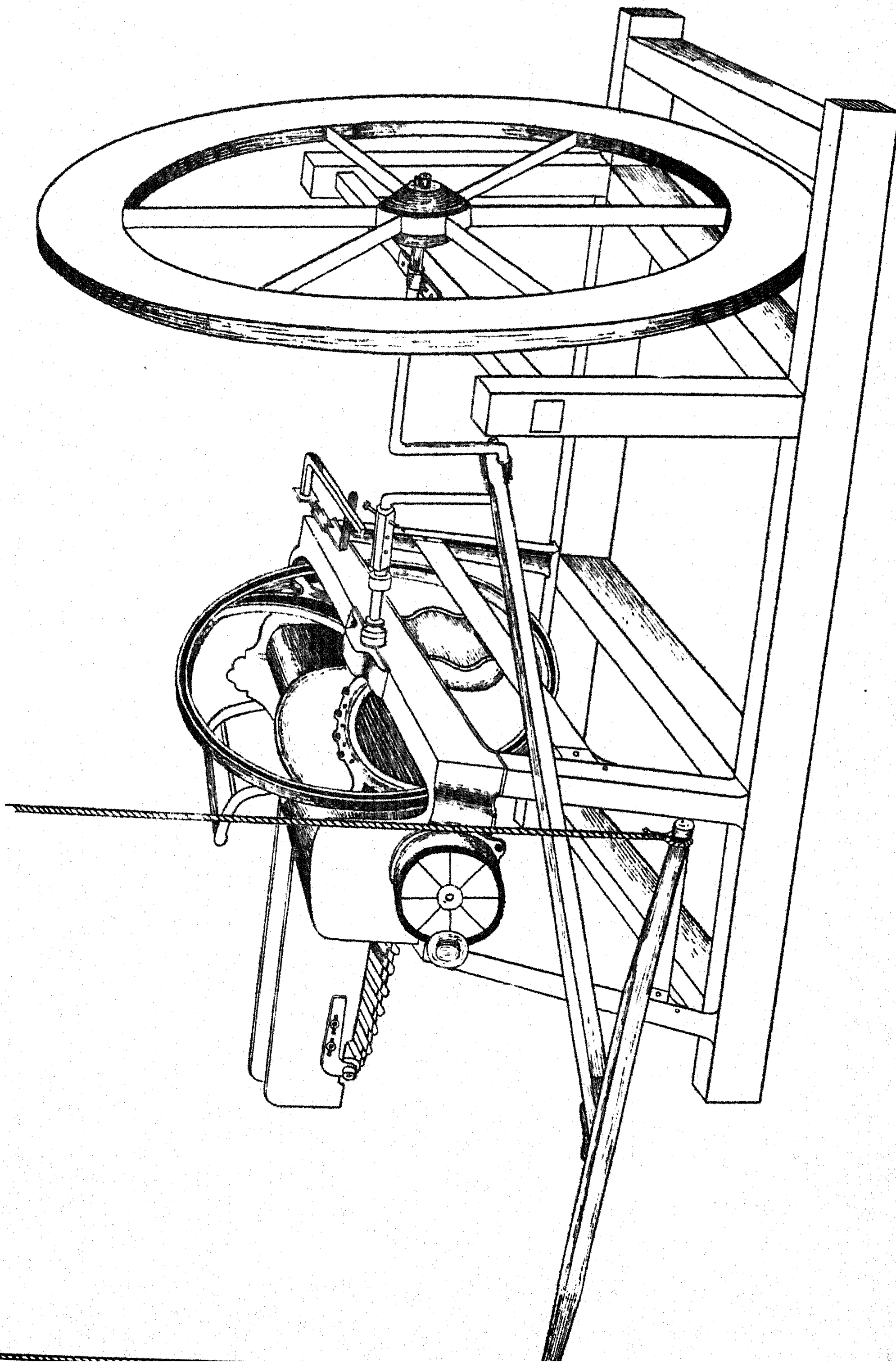

FIG. IV.

attached to the other end of this shaft serves as a handle and is made long enough for two or three coolies, standing side by side, to take hold of and work without interfering with the free motion of one another. The handle end of this shaft is suspended at a convenient working height by means of a rope (or sometimes by means of two ropes—one from each end of the handle) to the rafters or other over-head support.

By alternately pushing and pulling on this handle the fly-wheel is caused to revolve, and with a well-balanced "velocity wheel" a considerable speed is obtainable and can be readily maintained if the machine is not too heavily, but evenly, fed.

The writer is not aware that this arrangement is in use elsewhere in India, but with a little adaptation, especially of dimensions, it can be made use of for a variety of purposes. It is here made by local labour, the cost is small, and where coolie labour is as expensive as it is in Burma, simple appliances of this kind are very useful and quickly repay the expense and trouble of erection.

N.B.—The figures except fig. IV are all drawn to scale (one inch to one foot), the measurements being taken from the machine in use on the Mandalay farm.—(E. THOMPSTONE.)

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THE JAVA SUGAR INDUSTRY.—The imports of cane sugar to India in 1908-09 were 6,172,039 cwts. The figures for the previous five years are given below :—

	1903-04.	1904-05.	1905-06.	1906-07.	1907-08.
Quantity in cwts. ...	5,485,378	4,833,309	4,262,929	5,926,848	9,250,841

More than 60% of this comes from Java.

An interesting report on the trade of Java, which has recently been published by the Foreign Office and the Board of Trade (London), gives some details of the production of sugar in this island. The cultivation of the crop is largely under European control. The planted area in 1907 was 281,750 acres which produced 1,144,383 tons; in 1908 the acreage increased to

284,600 and the production to 1,217,390 tons, giving an average yield of 4·28 tons per acre. Less than 15 years ago, the total output was only half a million tons. The steady increase both in the area planted and in output, during this period, is strikingly indicated by the following table published in the *Louisiana Planter*, dated the 31st July 1909:—

Years.	Hectares of Cane planted.	Production of Raw Sugar in tons.	Production of Sugar in kilograms.	
			Per hectare.	Per 100 kill. of cane.
1894	77,919	530,963	6,814	10·36
1895	77,093	581,569	7,543	9·79
1896	73,993	534,390	7,222	10·55
1897	75,289	586,299	7,786	10·06
1898	80,337	725,030	9,025	10·21
1899	83,430	762,447	9,139	10·94
1900	90,775	744,257	8,199	9·57
1901	101,694	803,735	7,903	10·16
1902	104,167	897,130	8,612	10·77
1903	101,754	952,307	9,359	10·03
1904	103,037	1,055,043	10,239	10·74
1905	105,993	1,039,178	9,860	10·37
1906	110,752	1,067,798	9,611	10·04
1907	113,564	1,210,197	10,656	10·04
1908	117,579	1,241,885	10,562	10·04

Average percentage of extraction for last ten years is 9·417.

The ability of the Java Sugar Industry to compete successfully in the sugar markets of the world is attributed to the improved methods of production. A large proportion of the profits earned by planters is devoted to improvements in arrangements and construction of factories, to extension of systems of rail transport and to erection of new and improved machinery. At the Experimental Stations, valuable work is being done in the direction of propagating new species and in rendering existing ones impervious to disease.—(Editor.)

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The Experimental Error in Field Trials. In the August Number of the *Journal of the Board of Agriculture* (London), Mr. A. D. Hall, Director of the Rothamsted Experimental Station, draws attention to the fact that in all experimental work it is impossible to arrive at absolute correctness in results, and

that error is inevitable. As a consequence, perfect confidence cannot be placed in any conclusions drawn from experiments, to state exactly within what limits such results are likely to be correct.

All field trials are subject to a large number of sources of error. Those which relate to mistakes either of observation or of computation are, of course, such as cannot be taken account of in calculating the "probable error" and must be carefully guarded against. But there are others, such as, for instance, variations which reveal themselves in the soil in the course of experiments. In this case, the results obtained will be of no scientific value and experiments will have to be begun afresh. But even in cases where the soil may be said to be sensibly uniform, such as in pot and other culture experiments, it is found from actual experience that various pairs of plots receiving the same treatment do not give similar yields year by year, but vary with considerable irregularity. It is, therefore, necessary, says Mr. Hall, to find out what sorts of differences in the yields from two plots should be taken to indicate the effect of the treatment they have received, and what must be regarded as covered by the natural variation due to unknown causes. As the result of the examination of many series of experiments, he states that the mean error attached to the yield of a single plot is about 10 per cent., and he lays down for guidance the rule that nothing less than 20 per cent. differences have much significance in a single experiment. "The only way of reducing the experimental error and obtaining a closer result is to multiply the experiments, either by repeating them year after year, or by increasing the *number* of plots (not the *size*), preferably both, because there may be constant differences in the soil, while the season may also induce variations in the effect of treatment." In designing field experiments, Mr. Hall considers that it is useless to include small differences in treatment which are not likely to induce more than 10 per cent. differences in the yield, unless the experiment is going to be repeated very widely or carried on for several years.—(EDITOR.)

NOTES ON THE GERMINATION OF CANE SETTS.—Most Sugar Planters recognise the importance of getting quick and regular germination of their planting setts as a preliminary to securing a good "Stand" of cane and ultimately a good crop. The following observations in that direction may be of interest as they are the result of experience working on practical lines on about 150 acres. The canes used for planting were first year canes chiefly of the Red Mauritius variety. The soils on which my observations were made were of two kinds. One which I will call *A* is a very light sandy dry land soil of very low fertility. It is irrigated by an Oil Engine. The other which I will call *B* is a very stiff, wet land, clay soil of fairly good analysis, with, however, a tendency to be saline. It is irrigated by a canal. The cuttings planted in both plots were quite fresh and healthy, apparently free from disease and were carefully selected. Those showing signs of being damaged in any way were rejected. The setts in Plot *A* were cuttings from the entire cane ; "Tops," "Middles" and "Butts" being planted indiscriminately. The germination in this field was absolutely perfect. In about 35 acres with about 8,000 setts per acre planted not more than 3,000 "Replants" were required to give a perfectly filled field. The setts in Plot *B* were taken from the "Tops" and "Middles" of the cane. The "Tops" were planted separately from the "Middles" but in adjoining parts of the field. The germination of the "Top" setts was fairly good, but there was very high mortality amongst the "Middle" setts. This, I think, was caused to some extent by a heavy thunder storm which occurred while we were planting. We were faced by the work of replanting the failed portion of the field where the "Middles" had been planted and determined to do so with "Tops" as far as they were available. We had about two acres of standing cane and started cutting off the "Tops" for planting. A few days afterwards we noticed that the buds on those canes which had been topped were swelling, and from their appearance it seemed likely that in such condition they might germinate quickly if planted. The experiment was tried and proved highly successful. The portions of the field

where those budded setts were planted has now the most even stand of cane. With ordinary setts it was quite a fortnight and sometimes considerably longer before one could say whether germination had successfully taken place, but with the budded setts, it was possible to tell in about a week, the tender green leaf appearing in many cases within the week. The method we followed for planting the budded setts was pushing them an inch or two into the moist earth at a slight inclination. To sum up briefly what I have noted in this season's work.

1st. "Tops," "Middles," and "Butts" of canes may be germinated successfully in dry land if they are kept regularly irrigated and a little castor cake is applied in the rows before planting, thus preventing inroads of white ants.

2nd. To plant the "Middles" or lower portions of canes on heavy clay soil is very risky, and care must be taken to bud the setts before planting.

3rd. Budded setts are preferable to "Tops" for planting if considered from the point of view of germination. Tops are of course more economical as they are of no use for sugar making.—(WILLIAM NEILSON.)

***

AGRICULTURAL MACHINERY.—The *Times of India* says: "The successful competition of Indian wheat in the markets of the world will depend, to a great extent, upon the crops being handled chiefly and expeditiously by machinery. Little of this has been done as yet, though many unsuccessful experiments with unsuitable apparatus have been made in the Punjab. One of the greatest difficulties has been to devise machinery which can be driven across the irrigation *bunds* which intersect the corn-fields. This has now been overcome and an advance in the right direction is evidently now being made. The demand for machinery has largely been stimulated by the shortage of labour caused by plague and malaria, and the great efforts made by the Agricultural Department to introduce reapers among the Canal Colonists of the Punjab last year met with most satisfactory results. Forty-eight machines were disposed of, and a course of

instruction arranged for those who took them, and forty-three of the new machines were worked successfully. The very creditable all-over average of 5·6 or 7·3 acres was the daily work of the machines during the season, and with an average cutting of 72 acres, a hundred per cent. profit, after deducting depreciation, was shown. One of the most striking features of the whole undertaking was that the machines were almost entirely taken up by the Sikhs, a curious point on which it would be interesting to have some explanation. Another interesting feature was the co-operative purchase of several machines. The Agricultural Department of the Punjab have now succeeded in relieving themselves of the work of machinery agents, which has been taken up by a European firm of good standing, and with the financial success of the machine proved beyond doubt, they are certain to be adopted largely in future, though it is expected that their usefulness will be entirely limited to the Canal tracts."

* * *

Poultry Industry in Eastern Bengal and Assam.—An interesting Bulletin on Poultry Industry in Eastern Bengal and Assam has been issued by the local Department of Agriculture.

In this Province, Mahomedan families rear poultry at considerable profit. Fowls, ducks and ducks' eggs are sent in large quantities to Chittagong and Burma.

There is considerable room for improvement in the breeds kept, and this want can be helped from Pusa.

To introduce improvement in the local breed, the Department of Agriculture proposes on a small scale at the Dacca farm to breed and distribute male-birds of the Langshan and Chittagong kinds and to supply eggs of these pure breeds.

Pusa has got 19 pure English breeds of cocks and hens, geese, ducks and turkeys and can supply Provincial Departments of Agriculture with birds.

I am, however, not inclined to believe in the usefulness of keeping pure English fowls in India.

I recommend that crosses should be produced, and that the cross bred birds should be of medium size and good layers, because we do not usually want big fowls in India for the table.

Large eggs are, however, essentially required.—(Editor.)

* * *

Plantain Fibre.—An industry in plantain fibre is making considerable progress in the Madras Presidency, and there is considerable room for extension in other parts of India. The chief work has been done latterly by the Christian Colony of Malrosapuram, Chingleput, the Tanjore Industrial and Agricultural Association and the Cachar Industrial and Agricultural Association.

Mr. Proudlock, Superintendent of Parks and Gardens, Nilgiris, was really the pioneer of the industry in India and invented a very cheap and serviceable machine for extracting the fibre. The fibre is very suitable for making ropes though not as strong as Bombay hemp (*Hibiscus Cannabinus*).—(Editor.)

REVIEWS.

HANDBOOK OF THE DESTRUCTIVE INSECTS OF VICTORIA, PART IV, BY C. FRENCH, GOVERNMENT ENTOMOLOGIST.

THIS volume is a continuation of the author's well-known series, in which are described the injurious insects of Victoria. Part I was issued in 1891, an edition of 8,000 copies being now exhausted; the author hopes to add Parts V and VI. In the present volume twenty insects injurious to crops or forest trees are discussed, fourteen birds useful to agriculture are figured, an appendix dealing with spraying materials is added, and the volume starts with a copy of the Vegetation Diseases Act, 1896, the Act to amend it (1906), and a report from the Chief Fruit Inspector. The last three are interesting documents and illustrate the value put in other countries on checking crop pests. The Act of 1896 starts by saying that "no person shall sell or attempt to sell or expose for sale or cause to be sold or exposed for sale, any diseased tree, plant or vegetable;" the penalty is a fine not exceeding ten pounds. In the Colonies these matters are, as they should be, taken seriously, and a person who distributes diseased plants is as much a criminal as he who carries about an infectious disease.

The greater part of the volume discusses pests, the notorious fruit-fly pest, first of all. Many remedies for the fruit-fly are mentioned, but there is nothing really effectual to be done. Of the remaining pests, few have equivalents in India, and most are peculiar to Australia. The "Common Bean Butterfly" is represented in India by a very closely allied insect (*Catochrysops cnejus*), also attacking pulses. The author recommends spraying the beans, when quite small, with quassia; this should be repeated "at intervals according to the time of the year."

Another pest of interest to us in India is the Banded Pumpkin Beetle *(Aulacophora hilaris)* represented in India by *Aulacophora foveicollis* and *A. excavata*, which work in a precisely similar way, attacking young pumpkin, gourd, cucumber and other cucurbitaceous plants. It is noteworthy that though in India and Australia it is known where the beetle lays eggs, it is not known what happens after, and no one has found where the grub of any *Aulacophora* really lives; till that is found out, remedies must be directed at the beetle which alone is destructive. Mr. French recommends tar water and quassia chips as preventives, sprayed on to the plants, and gives particulars of many other methods used in Victoria. Another pest common to India and Australia is the bot-fly of the horse, for which the author quotes several remedies.

The coloured plates form a very prominent feature of the book and are both well painted and well printed. If there is a fault in the volume, it is that the author has no plan in dealing with each pest, but quotes or jots down snippets of information; above all, under prevention and remedies, a host of methods are quoted from persons who cannot be experts, whilst the opinion of the author himself is hidden.

We hope the volumes will be continued into Parts V and VI, completing this series which covers the pests not of Victoria alone, but very largely of the Australian continent; there is no other such comprehensive work of reference on Australian pests, and we congratulate the author on the success of this series and shall look for its continuation.—(H. M. LEFROY.)

* * *

THE SILK INDUSTRY OF JAPAN, BY I. HONDA, DIRECTOR, IMPERIAL TOKYO SERICULTURAL INSTITUTE, 1909.

THIS volume is published by the Imperial Sericultural Institute to give foreigners an idea of the Japanese silk industry. India has a dying silk industry; Japan a steadily increasing one; and the present volume is of very great interest to anyone concerned with sericulture in India.

We cannot here deal with this volume as it should be dealt with; we can only emphasise some of the salient points and contrast Indian with Japanese sericulture. The author dates the introduction of silk insects from China back 1,620 years. He recounts the efforts of successive Emperors and shows how the industry was built up. At a later date, the law restricted the use of silk clothing to the *samurai*, and as there was no export, the trade was restricted; the opening of harbours to foreign trade stimulated the industry; the immense demand for eggs in Europe at the time of the pebrine epidemic (1860-70) stimulated the trade still more, but with the introduction of Pasteur's methods, the demand for eggs ceased. In a separate chapter the author describes the efforts made by Government at the present time to foster sericulture; one of the most important is the Regulations for the Prevention of Silkworm diseases, which brings "all silkworm egg producers, silkworm rearers, raw silk producers, and those engaged in stifling and drying cocoons.........under the control of this law." The regulations prescribe for the examination of seed, and there are in Japan 132 offices which see that the regulations are complied with. The Government also started a Conditioning house, in which any silk could be tested and conditioned, so that it could be sold on a certificate, as is done in France.

There are in Japan hundreds of Sericultural Associations, the foremost being the Sericultural Association of Japan with a membership of 60,000; its scope is extremely wide, and there are very many minor associations which foster sericulture throughout Japan.

In 1876, the export of Japanese silk to America commenced, and it has steadily increased to the present, America being a very great market. The author details the efforts of Government to foster the industry; these led to the foundation of a Sericultural Institute in 1896, followed by a Filature Department, Sericultural Schools, and two Conditioning Houses; the sale and use of seed was regulated, and Pasteur's methods of examination made compulsory, so that pebrine and similar diseases have

not attained the importance in Japan that they have elsewhere. The author discusses the present state of sericulture. A total of 1,421,030 families were engaged in silk rearing in 1907; of the production of eggs, he states that the produce of 88,740,558 moths were used for cellular reproduction and 534,921,600 for industrial reproduction; the production of cocoons is given as 109,199,260 kilogrammes (equals approximately seers, or 2,729,981·5 maunds), and the production of raw silk as 7,631,095 kilogrammes (roughly 190,777 maunds). The area under mulberry varies from 31·5 per cent. of the land to 0·1 per cent. in the different prefectures; univoltine and bivoltine worms are cultivated, and there are three principal broods, the spring, summer, and autumn, the last obtained by keeping the eggs in caves which remain cool and so delay the hatching of the eggs

The author then enters into technical details of the processes of silk-rearing, reeling, etc., but his descriptions are not such as would help anyone actually engaged in sericulture in India. He gives an impression of the immense amount of care and trouble given to the work by all concerned in it.

In the final chapter he shows that Japan's production is 35 per cent. of the world's output. The efforts of Government are directed to increasing the export of raw silk rather than to that of manufactured products.

Contrasting the silk industry of India with that of Japan, the two salient points are that Japan has a climate admirably suited to sericulture, and secondly, that the care given by all classes of the community is far greater than that given in India; as a rule, Indian silk is badly and carelessly reared, unevenly reeled and put on the market without any care; no efforts on the part of Government would counteract the state of rearing and reeling in India, and the result is that India is an importing country, buying large quantities of silk that could be produced in the country. At the present time, the production of raw silk is not very large and is steadily decreasing in India; very largely is this due to the primary factor of climate; but it is also due to bad methods. There is no question that a very large area of India

can produce excellent silk, rearing one crop yearly from tree mulberry at the end of the cold weather; but if this production is to be such as can be used in India or exported, very much greater care must be taken in rearing, reeling and finishing than is taken at present. Sericulture is an art requiring infinite pains in every detail, and the present tendency is for sericulture in India to become extinct, the finer products of China and Japan replacing the inferior products of India in the world's markets and even in India itself.

Iwajiro Honda's book may be commended to the notice of those interested in sericulture; it shows what has been done in silk production by a people situated in circumstances not very dissimilar from those of the population of a large area of Northern India; silk production is practicable in India on the best lines, if sufficient care and attention to detail were to be given, and if the efforts of the people themselves rendered fruitful those of the Government, as has happened in Japan.—(H. M. LEFROY.)

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* *

THE RING DISEASE OF POTATOES, A PRELIMINARY REPORT BY LESLIE C. COLEMAN, M.A., Ph.D., MYCOLOGIST AND ENTOMOLOGIST TO THE GOVERNMENT OF MYSORE. DEPARTMENT OF AGRICULTURE, MYSORE STATE, MYCOLOGICAL SERIES, BULLETIN NO. 1, 1909.

THIS is the first of a series in which it is intended to publish the results of investigations conducted by the Agricultural Department of Mysore State. Each bulletin will deal with a single subject or with several closely related ones, and will be published as soon as the investigations have been completed or have reached a stage such that the results obtained are likely to be of practical value.

The present bulletin has been written expressly for the information of those interested in potato cultivation in Mysore. It is, however, of much wider interest, since the disease dealt with occurs over a considerable part of India, indeed probably to a greater or less degree wherever potatoes are grown. In Mysore it is well known to the cultivators, who often attribute

it to bad seed or to "sourness" of the soil and do not realise that it is a definite disease. In Bombay, where it has long been known, it is termed *Bangdi* blight.

It is readily recognised by the sudden "wilting" or withering of the potato plants in an affected field. If the tubers from one of these wilted plants be cut through, some of them are almost certain to show a brown ring in the flesh, a short distance below the surface. This ring indicates the position of the vessels of the tuber, which are found in diseased cases to be choked by enormous numbers of short rod-shaped bacteria. Besides the destruction of plants in the field, it is also found that the tubers from affected fields are very liable to rot when stored, part of the rotting being certainly due to the presence of these bacteria in the potatoes at the time of harvest. The vessels of the stem in wilted plants are also plugged with masses of bacteria. This prevents the passage of water from the roots to the green parts of the plant, and as soon as a large number of vessels become affected the plant withers, even though the soil may contain plenty of moisture.

The author, after describing the chief characters of *Bangdi* blight, furnishes proof that the bacteria present in the vessels are the real cause of the disease. This proof has been obtained by direct infections of healthy plants with pure cultures of the bacterium, the result being the production of wilting and the formation of the characteristic brown ring in the tubers.

The source of infection was next taken up and elucidated by carefully planned experiments. Two chief sources of infection occur. First, the use of previously diseased seed; if the seed is from badly diseased tubers, it often rots in the field without germinating; whereas if only slightly diseased, the plants grow, but most of them eventually wilt without reaching maturity. Second, the presence of the bacteria in the soil in which the potatoes are grown; quite healthy seed sown in a soil which had a short time previously borne a diseased crop, gave a crop which was badly diseased, while the same seed in a plot near by, where

potatoes had not previously been grown, gave a crop quite free from disease.

It was found during these experiments that diseased seed may occur without the warning brown ring in the tuber being visible.

The exact mode of infection is not yet definitely known. A similar, if not identical, potato disease in the United States is said to be chiefly carried by insects, which feed on diseased plants, getting some of the bacteria on their mouth parts during the process, and then inoculate healthy plants by feeding on them subsequently. The insects tested in Mysore did not convey the disease in this way, and it appears to be unlikely that insects have much to do with it The method of infection is being further studied.

Besides the potato, brinjals and tomatoes have been successfully inoculated with the bacillus, the result being wilting just as in potatoes.

The following are the chief recommendations for treatment made by the author :—

1. Seed should be obtained from fields where the disease does not exist.

2. As an additional precaution, where the seed is cut before planting, all pieces that have the least trace of brown spots or a brown ring should be discarded.

3. Potatoes, brinjals or tomatoes should not be planted in land which has shown the disease, for at least a year. Probably it would be better to wait for two years.

4. A means of checking the disease that would probably prove very effective would be the introduction of a disease-resisting variety of potato into cultivation. Attempts are in progress, with the co-operation of the Government Botanist, to secure such a variety.

The bulletin should be read not only by those concerned with potato cultivation, but by all mycological students in India, as a clear, easily followed and interesting account of a parasitic disease, the methods followed in its investigation, the ascertain-

ing of its cause, and how to combat it. It is profusely and excellently illustrated.—(E. J. Butler.)

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Drainage of Irrigated Lands. United States Department of Agriculture Farmers' Bulletin 371.

This bulletin deals with results obtained in draining lands which have been water-logged under irrigation chiefly in the State of Utah. Some ten areas have been dealt with. They were all badly water-logged mostly with accumulations of seepage water and usually accompanied with the natural accumulations of alkali. They were chiefly low-lying lands in which, after being under irrigation for some years, drainage from higher land, or in some cases seepage from the irrigation cut itself, had caused either total or partial reduction of fertility.

The system adopted consisted in running long lines of tiled drains to cut off the source of seepage water and leading to open ditches to the nearest outlet. Generally 4″ to 5″ tiles were employed, in some cases leading into 8″ and 10″ tiled drains. One area had long wooden boxes instead of tiles, but this proved expensive and unsuccessful.

Cost of the operations naturally varied according to local circumstances, but averaged $13 to $15 per acre.

An unqualified success has been claimed in nearly every case, but as the lands seem to have been usually nothing but bogs for a portion of the year, this is not surprising.

The system of laying single main lines of 4″ tiles up to 3,000 feet long would certainly be condemned by an English drainer. So naturally trouble was caused by tiles sinking in soft places, and difficulties in getting the proper bed slope occurred.

In one case the whole system was choked up by the irrigation water gaining entrance into the drainage tiles direct. This is a contingency which might easily occur.

On the whole, the results of the experiments do not seem to prove the superiority of tile drains over open drains for irrigated

land. If irrigation canals are properly protected by drains to prevent excessive seepage, there should be no difficulty in preventing water-logging and its attendant evils by means of inexpensive and easily constructed field ditches.—(G. S. HENDERSON.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1st AUGUST 1909 TO 31st JANUARY 1910.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	Report on the Progress of Agriculture in India for 1907-09. Price, annas 6.	Inspector-General of Agriculture in India, Nagpur, C. P.	Government Printing, India, Calcutta.
2	Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), 1907-1909. Price, annas 4.	Ditto.	Ditto.
3	*Agricultural Journal of India*, Vol. IV, Part IV; and Vol. V, Part I. Annual subscription, Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
4	Prospectus of the Agricultural Research Institute and College, Pusa.	Ditto.	Government Printing, India, Calcutta.
5	Short Courses in Practical Agriculture and other allied Practical subjects at Pusa.	Inspector-General of Agriculture in India.	Secretariat Press, Nagpur.
6	Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Departments.	Board of Agriculture in India for 1909.	Government Printing, India, Calcutta.
7	Potatoes—Cultivation, Manuring, Varieties, Storing and Seed supply in Bengal—Leaflet No. 6 of 1909.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
8	Simple Instructions on Arboriculture. Leaflet No. 7 of 1909.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
9	*Quarterly Journal*, Vol. III, Nos. 1 and 2. Price, annas 8 per copy.	Ditto.	Ditto.
10	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1909. Price, annas 8.	Department of Agriculture, United Provinces of Agra and Oudh.	Government Press, Allahabad.
11	Annual Report of the Cawnpore Agricultural Station for the year ending 30th June 1909. Price, Re. 1.	Ditto.	Ditto.
12	Annual Report of the Jalaun (Orai) Agricultural Station for the year ending 30th June 1909. Price, annas 8.	Ditto.	Ditto.
13	Annual Report on the Aligarh Agricultural Station for the year ending 30th June 1909. Price, annas 8.	Ditto.	Ditto.
14	Annual Report on the Partabgarh Agricultural Station for the year ending 30th June 1909. Price, annas 8.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
15	Pamphlet on Lucerne in Urdu and Hindi.	Department of Agriculture. United Provinces of Agra and Oudh.	Newal Kishore Press, Lucknow.
16	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1909. Price, annas 3.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
17	Annual Report of the Lyallpur Agricultural Station for 1908-09. Price, annas 5.	Ditto.	Ditto.
18	List of Improved Agricultural Implements recommended by the Department of Agriculture, Punjab. (Revised.)	Ditto.	Ditto.
19	Annual Report of the Department of Agriculture, Bombay, for 1908-09. Price, annas 8.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
20	Season and Crop Report of the Bombay Presidency for 1908-09. Price, annas 7.	Ditto.	Ditto.
21	Annual Report of the Surat Agricultural Station for 1908-09. Price, annas 14.	Ditto.	Ditto.
22	Annual Report of the Dharwar Agricultural Station for 1908-09. Price, annas 12.	Ditto.	Ditto.
23	Annual Report of the Dhulia Agricultural Station for 1908-09. Price, annas 10.	Ditto.	Ditto.
24	Annual Report of the Nadiad Agricultural Station for 1908-09. Price, annas 10.	Ditto.	Ditto.
25	Annual Report of the Manjri Agricultural Station for 1908-09. Price, annas 4.	Ditto.	Ditto.
26	Annual Report of the Lonavla Agricultural Station for 1908-09. Price, annas 3.	Ditto.	Ditto.
27	Annual Report of the Dohad (Mowalias) Agricultural Station for 1908-09. Price, annas 8.	Ditto.	Ditto.
28	Annual Report of the Kirkee Civil Dairy for 1908-09. Price, annas 4.	Ditto.	Ditto.
29	Annual Report of the Agricultural College Station (Poona), for the year 1908-09. Price, annas 4.	Ditto.	Ditto.
30	Annual Report of the Ganeshkhind Botanical Station for 1908-09. Price, annas 5.	Ditto.	Ditto.
31	Annual Report of the Bassein Botanical Agricultural Station for 1908-09. Price, annas 4.	Ditto.	Ditto.
32	Annual Report of the Mirpurkhas Agricultural Station for 1908-09. Price, annas 7.	Ditto.	Ditto.
33	Annual Report of the Daulatpur Reclamation Station for 1908-09. Price, annas 8.	Ditto.	Ditto.
34	Annual Report of the work done in Sind by the Agricultural Department outside Mirpurkhas and Daulatpur Stations for the year 1908-09. Price, annas 7.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
35	Night Soil—A Valuable Manure—Bulletin No. 34 of 1909, of the Department of Agriculture, Bombay. Price, annas 4.	G. K. Kelkar, Asst. Professor, Agricultural College, Poona.	Government Central Press, Bombay.
36	Report on the Operations of the Department of Agriculture, Madras, for 1908-09. Price, annas 6.	Department of Agriculture, Madras.	Government Press, Madras.
37	Scientific Report of the Hagari Agricultural Station for the year 1908-09. Price, Re. 1.	Ditto.	Ditto.
38	Scientific Report of the Bellary Agricultural Station for the year 1908-09. Price, annas 2.	Ditto.	Ditto.
39	Scientific Report of the Nandyal Agricultural Station for the year 1908-09. Price, annas 6.	Ditto.	Ditto.
40	Scientific Report of the Samalkota Agricultural Station for 1908-09. Price, annas 10.	Ditto.	Ditto.
41	Scientific Report of the Koilpatti Agricultural Station for 1908-09. Price, annas 3.	Ditto.	Ditto.
42	Scientific Report of the Palur Agricultural Station for 1908-09. Price, annas 3.	Ditto.	Ditto.
43	Scientific Report of the Taliparamba Agricultural Station for 1908-09. Price, annas 2.	Ditto.	Ditto.
44	Improvements in Paddy Cultivation of the Home Farm at Sivagiri—Tinnevelly District, Bulletin No. 61 of the Department of Agriculture, Madras. Price, 9 pies. (In English, Tamil, Telugu and Malayalam.)	J. M. Lonsdale, N.D.A., N.D.D., Agricultural Expert to the Court of Wards, Madras	Ditto.
45	Uses of the Harrow (in Tamil) ...	S. Subramania Iyer.	Ditto.
46	Cotton Cultivation (in Tamil) ...	A. R. Trimmuranganatham.	Ditto.
47	Single Planting of Paddy (in Tamil).	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Madras.	Ditto.
48	Agricultural Calendar for 1910 ...	Department of Agriculture, Madras.	Ditto.
49	Report on the Working of the Department of Agriculture, Central Provinces, for the year 1908-09. Price, Re. 1.	Department of Agriculture, C. P.	Central Provinces Secretariat Press, Nagpur.
50	Report on the Agricultural Stations in the Central Provinces for the year 1908-09. Price, Re. 1.	Ditto.	Ditto.
51	Report on the Management of the Provincial and District Gardens, Central Provinces, for the year 1908-09. Price, annas 8.	Ditto.	Ditto.
52	Annual Variations in the Character of Central Provinces Wheats—Bulletin No. 3 of 1909 of the Department of Agriculture, Central Provinces.	G. Evans, B.A. (Cantab.), Deputy Director of Agriculture, Central Provinces, Northern Circle.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
53	*Agricultural Gazette.* A monthly publication. Price, annas 2 per copy.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, C. P.	Central Provinces Secretariat Press, Nagpur.
54	Annual Report of the Department of Agriculture of Eastern Bengal and Assam for the year ending 30th June 1909. Price, annas 8.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
55	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
56	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
57	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
58	Annual Report on the Tropical Plantation at Wahjain for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
59	Annual Report of the Burir-hât Agricultural Station for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
60	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
61	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1909. Price, annas 2.	Ditto.	Ditto.
62	Year Book of Agriculture (in Bengali). Price, annas 2.	Ditto.	Ditto.
63	Supplementary Note on Jute in Rotation with Paddy in the same year and its effect on Food Crops.	Ditto.	Ditto.
64	Poultry Industry—Bulletin No. 22, of the Department of Agriculture, Eastern Bengal and Assam.	Ditto.	Ditto.
65	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June 1909. Price, annas 4.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
66	The Preservation of Mixtures of Sessamum and Groundnut oil. Cultivators Leaflet No. 18.	Ditto.	Ditto.
67	Sunn-Hemp Cultivation. Cultivators Leaflet No. 20.	Ditto.	Ditto.
	Agricultural Chemistry.		
68	Water Requirement of Crops in India. Memoirs of the Imperial Department of Agriculture, Vol. I, No. VIII. Price, Rs. 3.	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title.	Author.	Where published.
		Mycology.	
69	The Wilt Disease of Pigeon-Pea and Parasitism of Neocosmospora Vasinfecta Smith. Memoir of the Imperial Department of Agriculture, Vol. II, No. IX. Price, Rs. 3.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
		Economic Botany.	
70	Second Report on the Fruit Experiments at Pusa. Bulletin No. 16 of the Agricultural Research Institute, Pusa. Price, annas 6	Albert Howard, M.A. (Cantab.), A.R.C.S., F.L.S., Imperial Economic Botanist, Pusa.	Government Printing, India, Calcutta.
71	The Milling and Baking Qualities of Indian Wheats No. 2. Bulletin No. 17 of the Agricultural Research Institute, Pusa. Price, annas 6.	Ditto and Gabrielle L. C. Howard, M.A., Associate and late Fellow of Newnham College, Cambridge.	Ditto.
		Entomology.	
72	The Red Cotton Bug. Cultivators Leaflet No. 19.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.

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THE CATTLE CONFERENCE AT LUCKNOW.

By W. H. MORELAND, C.I.E., I.C.S.,

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I HAVE been asked by the Editor to give a short account of the proceedings of the Cattle Conference which was held last August at Lucknow, and which excited a quite exceptional amount of attention in the United Provinces. The idea of the conference was not a novelty, since it had been preceded by the Industrial Conference of 1907 and the Sanitary Conference of 1908, the object in each case being to ascertain through free discussion the views of representatives of the public, and to formulate the main lines of a policy to be pursued by Government on the subject under consideration.

The Cattle Conference had its origin partly in the general feeling of dissatisfaction caused by the high prices of cattle and of dairy produce, and partly in the desire of the departments most directly concerned to obtain an authoritative expression of opinion on subjects where the religious and social sentiments of the people can never be left out of account. Membership was limited to representatives of the province, but among the visitors were the Inspector-General of the Civil Veterinary Department and two representatives of the Military Department. The members fall naturally into three groups, the divisional representatives, the Government nominees, and the official element. The divisional representatives were chosen on the nomination of Commissioners from among Indian landholders who were most likely to represent the feelings of the agricultural population; the Government nominees were for the most part representative of special interests, and included besides European planters and landholders and representatives of the Upper India Chamber of

Commerce, such authorities as Mr. Abbott of Jhansi, the pioneer of the Central Indian hay-trade, and Mr. Keventer of Aligarh, the leading dairyman in Northern India; the official element consisted of representatives of the general administration and of the Public Works, Forest, Agricultural, and Veterinary departments. In all about forty members met under the presidency of the Hon'ble Mr. D. C. Baillie, a Member of the United Provinces Board of Revenue; and it must be said that a more competent and authoritative Conference could scarcely have been brought together.

The proceedings opened on the 4th of August when the Lieutenant-Governor welcomed the members and the president delivered his address. The Conference then divided into committees which sat for the next three days, discussing the agenda with an entire absence of formality, set speeches being practically ruled out, and the tone of the discussions being throughout friendly and conversational. The recommendations of the committees were then discussed by the full Conference, and transmuted into a series of Resolutions which form the final record of the results of the deliberations. The discussions were for the most part conducted in the vernacular, and the papers circulated daily were accompanied by translations, so that no difficulty was caused by the presence of members unacquainted with English.

Turning to the Resolutions that were passed, the first group recorded the actual position. It was held that though prices have increased, especially for the better class animals, there was no actual insufficiency of working cattle; but there were differences of opinion on the question whether the class of animals had deteriorated. It was recognised that the decrease in cows disclosed by the cattle-census was probably temporary, being due to recent famines, and that there is a tendency to substitute buffaloes for cows among dealers in milk. The general feeling was that the fully-cultivated districts of the province must continue to depend for the supply of cattle on the grazing-districts which lie on the North, South and West, and that the protection of the grazing-grounds was a matter of great importance.

When, however, the question of legislation to protect grazing-grounds came under discussion, there was a marked divergence of opinion: the representatives of the cultivated districts desired to have the large grazing-grounds protected by law, but this was strenuously opposed by the representatives of those interests, who in turn recommended the reservation of grazing areas in the cultivated districts, a proposal that was opposed by some of the representatives of the cultivated districts. Eventually no agreement could be come to on this question, and the present position is likely to be maintained: the larger land-holders voluntarily preserving the existing grazing-grounds, though objecting strongly to being compelled to do so, and the smaller men breaking up the land for cultivation until the necessary adjustment in prices ensures its retention for grazing.

Leaving the recognised grazing-grounds, the Conference then turned to consider the question of preserving and improving waste land of other kinds. Recommendations were made for administrative action tending to increase the number of the groves which are such prominent features in the landscape of the province; co-operation was offered in the efforts of Government to increase the productivity of the ravine area; and a request was made for experiments to be instituted to show whether fuel and fodder reserves can be made a commercial success on land which is on the margin of cultivation.

The Conference then considered the fodder-supply, and an interesting discussion took place on the contention which has been frequently advanced in the past that the provision of more fodder merely leads to the survival of useless cattle, and that cattle will always multiply up to the limit of subsistence in years of plenty and die off in years of dearth. It was conclusively shown that this contention no longer applies to the circumstances of the province, as animals past work are now speedily eliminated in almost all districts. Thus, the main argument that has been used in the past in support of a policy of inaction is no longer available, but few definite recommendations for increasing the fodder-supply

could be made, as it was recognised that this must be governed mainly by economic conditions.

The next discussion of special importance related to the supply of bulls. So far as the valuable breeds in the north of Oudh are concerned, it was recognised that the bull-depôt now being established by Government should meet the needs of the case; but there was a general feeling that Government should provide a supply of ordinary bulls, which landholders could purchase in order "to supplement, and it is expected in time to supplant" the present system under which the village cows are ordinarily covered by sacred bulls. The recognition by such a body of landholders that the time-honoured system of providing bulls as a religious act is wearing out and requires to be supplemented, and eventually supplanted is a matter of the greatest interest, both socially and economically, and raises a problem of much practical importance in the supply of sound bulls at reasonable prices.

The question of introducing improved breeds either for work or for dairy purposes produced another interesting discussion, in the course of which it was clearly recognised that organised action is necessary, one or more bulls and a suitable number of cows being introduced simultaneously into a definite area. It was thought that large landholders might undertake this on their estates, and that it is a most suitable function for local agricultural associations, Government assisting in the work of purchasing the stock, and where necessary granting advances towards its cost.

Turning to the prevention of disease, the increased popularity of the Civil Veterinary Department in recent years was shown in a most gratifying manner by the general demand for more veterinary assistants and for increased attention to the treatment of cattle; and the Conference was able to recognise that the prejudices against inoculation are disappearing and that the influence of landholders is the most important factor in this matter.

The supply of dairy products was the next topic, and the Conference declared that there was no disproportionate rise in

price, but that adulteration was greatly on the increase, and they recommended legislation, applicable only to towns, providing that nothing should be sold as milk, butter, or *ghi*, which is adulterated. A similar recommendation had previously been made by the Sanitary Conference, and it is understood that legislation is in prospect. Recommendations were also made to municipalities for the encouragement of sanitary dairies in their vicinity, and to the railway systems for developing the supply of milk by rail.

Finally a recommendation was made for an enquiry into the sources of cattle-supply to the various districts, and for the collection of information on various points which had come up during the discussions; and the Conference broke up with mutual expressions of cordial good-will between the official and the non-official members. Perhaps the final result can best be summarized in the following words, with which the Chairman submitted its proceedings to Government:—

"It cannot be claimed for the Conference that it has suggested any fresh or original measures to help towards the solution of the problems considered by it, but the meeting was certainly not without value. It has led to the discussion from all points of view of the questions raised by a considerable body of landholders, and it has given evidence of a general desire to give personal assistance in future measures and assurance that there is no general tendency to look at these questions from a narrow or sectarian point of view. The general agreement of the members of the Conference gives good reason to believe that so far economic changes have not produced acute difficulties in connection with the production of plough and milk cattle, and affords indications that further developments will be on natural lines."

THE INTRODUCTION OF IMPROVEMENTS INTO INDIAN AGRICULTURE.

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THE introduction of improvements into Indian Agriculture is surrounded by peculiar difficulties. The fact that, generally speaking, the agriculture of the country is in the hands of very small holders, who form a naturally non-progressive class, is the first of these. Perhaps of equal importance with this is the rigid separation, which has long existed and still exists, between the different classes of society throughout the larger part of the country, for as a result of this, the educational movements of the past few years have hardly touched the cultivator of the land. He, in fact, still remains largely out of contact not only with progress, but also with the knowledge of progress. And, if you add to these reasons the fact that the Indian farmers are usually men whose capital is little more than the ownership of their very small area of land, who work almost entirely on borrowed money, there results a condition of things which is eminently unfavourable to progress.

This condition of things places India in the opposite extreme to those countries where the application of modern scientific discovery to agricultural practice has been most marked. Take, for instance, the United States of America. *There* your farmers are men of energy, of, at least, a little capital, and who are intensely alive to all that is passing in the great world : *here*, on the other hand, they are isolated, they are poor, they are usually content to go on in the way of their fathers. *There*, the existence of a large and well-organised agricultural department, of agricultural societies, of rural banks is the result of initiative among the

farmers themselves : *here*, that initiative is all but entirely absent. *There*, as a result, experiment and discovery are followed closely by a large and intimately-interested community : *here*, the results of any experiment or any discovery have to be forced on the attention of the people, and its adoption in practice has to face an amount of inertia, and a lack of available capital that would seem inconceivable in most other countries.

And yet, it must not be understood that the Indian cultivators are themselves hopelessly conservative and prejudiced. The difficulty seems rather to be, first, to get information actually into their hands from a source in which they have confidence, then to convince them of the utility of the suggestion which is made, and finally to show them that it will pay them to adopt it. When this has been done, the increasing experience is that the Indian cultivators are by no means over-conservative. They are quick, in fact, to see any advantage. But, owing to their economic position, they must be sure of the disinterestedness of the information, they must be fully convinced of the value of the improvement, and they must be sure it will pay.

And what will pay under Indian conditions is quite a different thing from what will pay in many western countries. It is impossible to estimate the value of any method or of any change, unless the financial conditions under which a cultivator works are fully realised. As already stated, it is probable that over the greater part of India a cultivator does not have any ready capital. He has to borrow every year, either in money or in kind, for the purpose of meeting the expenses of cultivation, and the rate of interest which he has to pay often, if not usually, amounts to from 25 to 75 per cent. per annum. It is, therefore, not sufficient that an expert in agriculture can prove to himself that a new method will give a return of 10 or 20 per cent. over existing practice. Account must also be taken of the extra capital involved, and the rate of interest which will have to be paid for it. As the cultivators have no capital they can take no risks. Unless they can be shown that the new method is a certainty, the cultivators will not, and rightly will not, take it up. A

certainty will mean, as a rule, to a ryot, something which will give him a return of over 25 per cent. on any extra capital invested, and this fact must be continually in the minds of all those who propose innovations in Indian agriculture. This means, in other words, that until cheaper money can be made generally available, any improvement which can be brought into practice, if it involves any outlay, must be of a very marked character. It means, further, that the connection of effort for cheapening of credit by means of co-operation or otherwise, and that for agricultural improvement is very close,—closer perhaps than is generally realised.

But apart entirely from these questions, the introduction of improvements into Indian agriculture is no easy matter. But a considerable amount of experience has been gained in the last few years. Many failures have occurred : some successes have been obtained, and with a view to bring together the results of these experiences for future use a committee was appointed at the meeting of the Board of Agriculture in 1908 to consider and discuss them, and express an opinion as to their applicability in the future. A second committee was appointed in 1909, and the results of its deliberations, modified as they have been by careful local examination of the statements, will be issued very shortly. It seemed, however, that there was room for a general statement of the methods which had been found to be most effective in the present article.

To introduce anything which may be considered an improvement in the special conditions of Indian agriculture, the first necessity is that you should be absolutely certain that your process or implement is actually an improvement under the conditions existing in any particular spot. This would, at first sight, seem a truism, and and so it is. And yet, its neglect has led in the past to the greatest failures, to the loss of confidence by the *ryots*, and to sets-back to progress whose seriousness it is difficult to estimate. In the older days, for instance, American cotton was introduced into India in very large quantities. No experiments were made as to its suitability in many of the

areas, where it was planted, either agriculturally or economically. What was the result? The cotton failed in many areas, of course. This would not have mattered so much, perhaps, in itself, but confidence was lost, the department introducing the cotton was thought by the cultivators to be unpractical, and they hesitated, to say the least, to adopt any other suggestion. The same story has been repeated elsewhere; new implements, new crops, new methods, excellent in themselves, have occasionally been introduced without adequate knowledge of local conditions, and without sufficient testing. The result has too often been failure, loss of confidence, and general distrust. It cannot be too strongly insisted on, that nothing can justify the recommendation of any supposed improvement, unless it has been preceded by careful experiment, and by the most careful local study.

But what does this careful local study mean? Does it simply mean that the method has been carried out successfully on an experimental farm in the same neighbourhood? So far as it goes, such experimental testing is excellent, but it is by no means all. Anyone who has dealt with this subject in practice must know that the difficulties which occur to an experimental farm manager are a very different thing from those which occur to a ryot. For instance, on an experimental farm a particular imported iron plough does excellent work, it is more economical in every way, and the crops are better. You take it out, and are met at once by a villager who acknowledges its value, but at once asks how he is to get it repaired if he adopts it. No country *mistri* can deal with it, spare parts cannot be stocked either by the cultvator himself or in the village shop, and the plough, however good, has to wait until this difficulty is overcome. Or again, you find a particular manure for sugar-cane. It gives excellent results in growth, and yield of *gul*. You recommend it, and are at once met by the statement that this manure always lowers the value of the *gul*. The lowering is relatively small, but there it is. It is probable that among the mass of samples on your experimental farm the difference has never been noticed,

especially as it is a commercial difference not capable (so far as I know) of being detected by chemical analysis. But you must answer the difficulty or your manure will have to wait. And so on. Instances might be multiplied, but the above must suffice to show the absolute necessity of local study as well as experiment before it is attempted to introduce an improvement. The whole resolves itself into being absolutely certain that your novelty is good and is applicable under the special local conditions.

But this being ensured, the next step is to secure the confidence of the people. And here is perhaps the greatest difficulty of all. Indian ryots have from time to time been exploited by people of the most various kinds, sometimes with, sometimes without, intention, so that they are rightly suspicious. If anything is suggested, they at once look for the motive. What has the man to gain by it? What has the Government he may represent to gain by it? Is he the agent of someone else? Such are the questions which at once rise in his mind, and have to be met.

The winning of confidence has been accomplished in various ways; but whatever the method, it is of the first and most vital importance to the whole success of the work attempted to be done. In many parts of India the attempt has been made by the formation of local associations of agriculturists and those interested in agriculture among whom the improvements suggested can be discussed, by whom they can be tried, and, through whom, when successful, they can be extended among the surrounding people. Perhaps the greatest success in this direction has been achieved in the Central Provinces. There the members are nominated by the local authorities, they have as their chairman the District Officer, whenever they meet one of the senior officers of the agricultural department is present, and membership involves readiness to try some novel method on the member's own land. All proceedings are in the Vernacular, discussions are free, and enthusiasm is often aroused, and these associations have succeeded in bringing the agricultural department into touch with the cultivators, and in giving them confidence in one another. As a result

numerous improvements have been made. Improved varieties of Jowar, sugar-cane and other crops have been introduced, the fighting of *smut* in *Jowar* by pickling the seed has been largely adopted, in some of the backward tracts great improvement in rice cultivation has taken place, and new, improved implements are now in some districts regularly used. I have quoted the Central Provinces because the idea of agricultural associations has been more developed there than elsewhere, but they have been formed in other provinces, sometimes as more independent, sometimes as more official bodies, with varying success. The movement is in its infancy, but enough has been seen to indicate the general lines in which they are likely to be most valuable. In the opinion of the Committee (whose work I am summarising), it may be said that "their utility seems largely to depend on the presence of a body of men directly interested in cultivation, on the personal touch of the higher staff of the agricultural department with the members, on the definite engagement by the members to do definite pieces of work, and on the regularity of meetings, inspections, and reports .... No association, large or small, should be formed till there is something of the nature of a spontaneous demand on the part of the people themselves or until the agricultural department is in a position to advise and guide them in their work. Where the agricultural department has failed to create such interest the association is bound to fail in its object."

The next method which has been used, is that of demonstration of the value of improvements on the spot, usually by instituting a demonstration farm for the purpose, or by temporarily hiring some land from an actual cultivator. In either case, if it is to do any good, the confidence of the people must be won either before or during the demonstration itself. Nothing is more common than to find that the cultivators have a haughty disdain of what is done on a Government farm,—it is considered that, however good the results may be, they can only be done under conditions of money and *personnel* that only Government can secure. Hence, except in

exceptional cases, it is probably not wise to institute a special permanent farm for demonstration purposes; by far the better way, so experience shows, is to engage a temporary plot or utilise a private farm. It is essential that everything be done as a cultivator can do it, and that the man in charge should be a cultivator himself, or at any rate one with whom they can get into perfect intimacy. Supervision there must be, but it is essential that the man actually in charge should be of the same type as the people he is working among. He has then two things to do, to gain their respect and confidence, and to show that his method is better than that which is adopted round about him. He must understand, too, that the success of the demonstration will be judged by the extent to which it is adopted, and that this is the only test.

Working on these lines it has been possible to make considerable progress in Madras, in the Central Provinces, and in several other parts of India,—new varieties of crops have been introduced, new methods have been largely adopted, and it seems likely that this will form one of the most effective means of introducing new matters into the practice of cultivators.

These methods are not limited to matters of cultivation. New machinery can be equally well shown by men of a similar type. A gang of men has for instance been employed for years in Bombay, demonstrating from place to place, the best methods of boiling *gur* (crude sugar): the use of reaping machines has been brought to the notice and into the practice of agriculturists in the Punjab similarly, and many other cases might be cited. The essential point in it all, is that everything should be shown under cultivators' conditions, by men who are themselves intimately in touch with the people and their problems.

Other methods have been utilised for gaining the confidence of the people, the essential preliminary to doing very much for the introduction of improvements. In the United Provinces and in the Central Provinces, advantage has been taken of the period of stress following severe famine to help the cultivators with large quantities of good seed, and the like, and the confidence thus

gained has been very great. Again travelling agents have been employed in going from place to place, generally on some special quest, and getting into touch with villagers and cultivators in Bombay. In this case the men employed should be of considerable experience, be thoroughly imbued with the fact that they are the servants of the people, and be, if possible, cultivators themselves. And so on. But confidence must be gained, I would again insist on the matter, before anything material can be done.

When the confidence of the actual cultivators has been secured, the greater part of the difficulty is over. It is then only a matter of showing, of clearly proving, that what you recommend is good and will pay, and the chief trouble is to ensure that your information actually reaches the cultivators themselves.

The number of methods which can be adopted for this purpose is very great. The most certain in effect have been already referred to, the formation of local associations of agriculturists where matters can be freely discussed, and in connection with which members will make trials for themselves and for their neighbours to see, and the institution of demonstrations by the agricultural department either on cultivators' land specially hired for the purpose, or by special demonstration farms. Where applicable, both these methods are effective, in almost all cases. The spreading of demonstrations over larger areas under the control of the agricultural department, however, involves a very large staff, and a very well-trained staff. This is not likely to be available for many years to come, if ever, but so far as it is available, whenever there is anything definite to be shown, the method of local demonstration has proved itself extremely effective. As already stated, the Committee feel that experience has shown that plots taken from cultivators for a short period, and placed under a man who is himself a cultivator well trained for the particular demonstration in hand, are more effective than actual demonstration farms. Such plots should be small, should limit themselves to special and definite demonstrations, should show nothing which is not certain to be a success, and should be accessible to surrounding cultivators at all times.

But beyond the relatively small area which even a very large extension of such demonstration areas would cover, we must rely on agricultural associations to meet the need to a large extent. As already described, they enable us to carry the ocular demonstration of our improvements to a very much larger area, but their number is circumscribed by that which can be covered by the senior staff of the agricultural department, who must act as inspiring and suggesting influences to everyone. However enthusiastic local men may be, they expect and require constant touch with the experts of the agricultural department, and the extension of associations is limited by the possibility of giving that touch. It is no use sending inferior men to them, those employed to guide and assist associations must be of considerable experience, usually well-skilled in the vernacular, capable of inspiring work, and with a stock of suggestions for improvement which are proved successes, and which will meet the cultivators' needs.

The last point perhaps merits a short digression. It is impossible to insist too strongly on the necessity for finding out what are the cultivators' difficulties and needs, before any attempt to introduce improvements is made. It is a slow business to attempt to bring into use anything for which a need has not arisen. It is useless to talk of artificial manures to a man whose crops are failing for want of water, and yet this has often been done in the past. It should always be remembered that the finding out of the cultivators' wishes and needs is the first necessity, and the devising of means to meet them the second, and their presentment to him in one way or another then follows and is welcomed.

To enable improvements to be carried out over a wider area, we must return to those methods which have been successes in other lands,—such as exhibitions, shows, publications and so on. They will be successes if you already have the confidence of the people, otherwise they may cause much talk, but will lead to little real effect. Hence the value, so far as ultimate results are concerned, of these methods has been very various. But if the essential

condition is obtained, then a great deal depends on the manner in which these methods are adopted. A large amount of energy has been spent in recent years in organising large exhibitions in several Indian Provinces in which a vast amount of work has been put into the agricultural section. These have been held in Bombay, at Calcutta, and the culmination was reached in that recently held at Nagpur. In each of these cases, and particularly at Bombay and Nagpur, very great efforts were made to secure the attendance of large numbers of actual cultivators, and to show them everything which was to be seen. These exhibitions have certainly been effective in inspiring very great interest, have made the agricultural departments more widely known, have spread the knowledge of advanced methods into corners where this had never before penetrated, and have directly led, in the hands of the more substantial cultivators, to the introduction of seed and implements.

Such large exhibitions can only, however, be organised on special occasions and under special circumstances. Local smaller shows can be held at more frequent intervals, and range in size from institutions like the Lyallpur fair in the Punjab, annually attended by one hundred thousand people, to small *taluka* shows in parts of the Bombay Presidency, or to the demonstrations which are made in connection with smaller cattle fairs and festivals in Madras. On the whole, the Committee have felt that if such shows are to lead to real effective improvement, their organisation should be very carefully done. While local effort may and should arrange the show, the part which the agricultural department takes in it should be very carefully organised and attended to by one of the superior staff of the agricultural department. Agricultural products which are not and cannot be produced on the cultivators' own lands should be excluded. As many things as possible should be shown in action; as these are always centres of attraction. Popular lectures should be combined with practical demonstrations. Farm produce should be arranged in sufficiently large quantities to allow of being handled by those interested in them. If these conditions

can be attained, it is probable that a larger number of smaller shows are more useful than fewer shows on a larger scale.

It may be well to consider the whole question of agricultural publication together, so far as it is made for the purpose of introducing improvements into practice. In some parts of India, vernacular agricultural journals are issued, in some information which it is desired to spread is sent out in leaflets, in others again the general press is considered sufficient, and in Madras, an agricultural almanac in the various vernaculars is published. It is natural that in a matter like this the methods should differ, in each part of India, as the habits of the people vary. But whatever is done must be done well, and must be written simply and in such language as the cultivators know. This latter point is of importance, for there is a danger that if a translation into the vernacular be made by a non-agriculturist, it will abound in phrases and words totally unintelligible to the ordinary cultivators. Again, any article, any leaflet, should be short, perhaps not exceeding a couple of pages, and should contain one definite fact or the description of a single process which it is desirable that the *ryot* should know and adopt, with illustrations whenever possible. The circulation of such material is a difficult point. A vernacular journal, which has to be paid for, is excellent if it only has a large enough circulation among actual cultivators. Such a circulation is not very easy to work up,—and the agricultural department in the Central Provinces is the only one in India by which this has been really accomplished. Leaflets, being distributed free, can be spread more widely, but much of the distribution is useless. To avoid this they are, in Bombay, generally used (1) in connection with demonstrations of implements and methods, as for instance at shows; (2) in a limited area where special need has arisen. They are rarely distributed without at the same time arranging for the presence of an officer who can explain the nature of the improvement. Even with all these precautions, the extent to which such leaflets are really useful is still problematical.

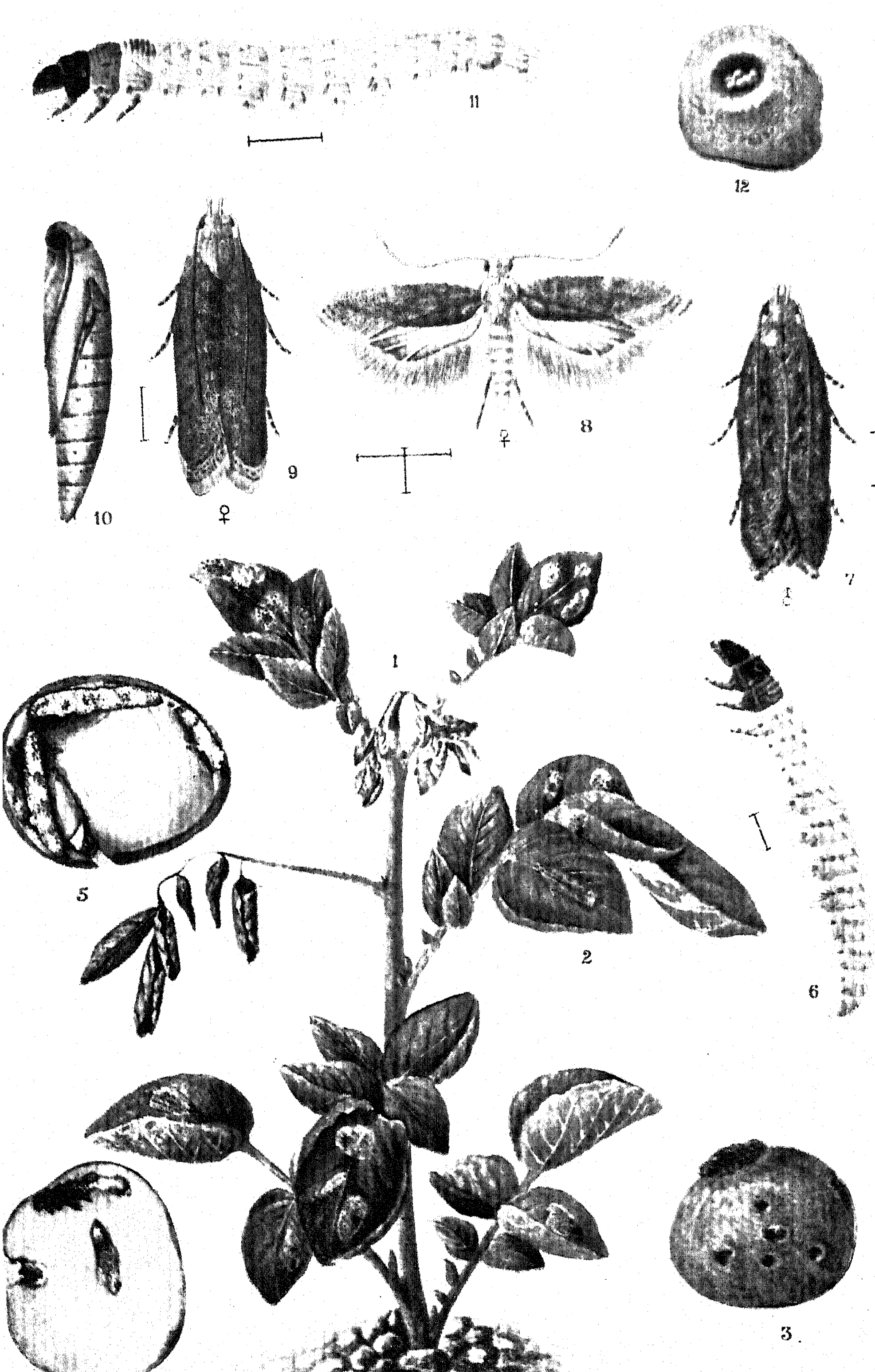
Of course, it is possible to use the general vernacular press for publication of agricultural information. This is now very widely read, in by far the greatest amount, however, among the non-agricultural classes. Articles and material are however freely taken, and with a properly organised system of contribution, a considerable result might be expected to flow from its utilisation. If material is sent to the press for this purpose, no efforts should be spared to give the contributions a popular readable form, such as likely to command attention.

We have now considered most of the methods which have been adopted to ensure a wide extension of the knowledge of agricultural improvements. But there is one other to which I would like briefly to refer, namely, the training of the sons of cultivators in practical agriculture either on the farms of the agricultural department, or in special institutions. This has been carried on to a certain extent at Nagpur, and also in Bombay. The whole matter is, however, as yet in an experimental stage. Difficulty has been found in attracting the right class of student and those who come do not by any means always wish to go back to improve their own land. Where the right type of boys have been attracted, and where the course has been short and practical throughout, there have, however, been a good number of cases of success. But the whole question of the large applicability of such training is at present doubtful, and a very considerable amount of experiment will be required, and that under different conditions, before the best method is ascertained.

I might refer to many other methods which are of narrower application, but have been of service on particular cases. In certain cases lands have been colonised with good cultivators with very great effect on the character of the agriculture round about them; in others, individual cultivators have been sent to new areas to teach the people round about them, their own methods, and so on. But again it must be recognised that there is no general method; the conditions differ so much from place to place, and from province to province, that it is absolutely impossible to lay down anything more than indications of such

methods as have, in particular places, given successful results in the past.

In conclusion, there is sufficient information in hand now to indicate that, in spite of its peculiar difficulties, agricultural improvement is not impossible in any part of India. There is, however, no royal road,—the progress is, and must be for a long time to come, very slow. But, whatever methods be adopted, the actual process must be the same. To find the cultivators' real difficulties, to discover a practical and certain method of meeting those difficulties, to gain the confidence of the people: these all must precede any definite attempt at a propaganda. If the attempt is made to introduce so-called improvements without these necessary preliminaries, then not only will failure result, but what confidence there may be will be undermined, and progress in the future will be made harder. Recognise the necessary order of events, try to satisfy the cultivator's needs and not something you imagine he ought to need, let your experiment be based on the requirements of the ryot, and success, though slow, will, if past experience be any guide, be sure.



Frontispiece.

PHTHORIMAEA OPERCULELLA.

(LITA SOLANELLA.)

Potato Moth.

Fig. 1. A potato plant showing injury caused by the larvæ.
,, 2. Moth resting on plant.
,, 3. Potato tuber showing evidences of caterpillar attack in the masses of excrement at the eyes. A cocoon on the tuber.
,, 4. Potato tuber cut open to show damage caused by caterpillar.
,, 5. Potato tuber showing the track of the caterpillar and the pupa.
,, 6. Young Larva.
,, 7. Imago, male.
,, 8. } ,, female.
,, 9. }
,, 10. Pupa.
,, 11. Adult larva.
,, 12. Eggs deposited at the eye of a potato tuber.

EXPERIMENTS IN THE STORAGE OF SEED-POTATOES.

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In almost all parts of India where potatoes are grown, the tubers for seed have to be kept for a period of several months, usually during the rains, and during this time they are extensively attacked by disease and are consequently difficult to keep. There has been for years past a very large import of seed-potatoes from Italy, and there is little doubt that with these potatoes has come the potato-moth which is well established in Italy, Algeria, and other countries on the Mediterranean and which has been spread from there to Australia and other countries. The importation of the potato-moth not only let loose an insect attacking the growing plant, but also one which immensely increased the difficulties of the potato-grower who stored his own seed; the pest attacks the stored potato freely, and has become well established in India where potatoes are grown.

To meet this pest it was necessary to devise a new method of storage; there must be no access of the moth to the potato in the first place, that is, the potato must be covered; it was soon found that storing the potatoes in a closed space or in bags was impossible owing to the enormous loss from disease and a long series of experiments was undertaken to determine exactly how the potato could be stored, so that it would not be attacked by potato-moth. These experiments were made at Pusa in 1908

and the results were applied in the Central Provinces as described below.

The potato-moth is shown in all its stages in Plate I; the moth is a small brown insect, which can be seen in hundreds flying about potato fields, and is abundant in houses in which potatoes are stored; the eggs are laid on the tuber, usually in an eye or on the under surface of the leaf of the growing plant usually at the angle of two veins; in the plant the caterpillar becomes a miner, making a blotch mine in the leaf (Plate I, fig. 1) or it bores in the shoots or leaf petioles, causing the shoot or leaf to wither; in the tuber the caterpillar tunnels in the potato entering at the eye and the presence of the caterpillar is shown by the black excrement grains on the outside of the tuber (Plate I, fig. 3). The full-fed caterpillar pupates in the tuber (Plate I, fig. 5) or if on the plant, in any convenient shelter on the leaves, stems or ground, in a light cocoon.

The whole life-history occupies about one month; a single cycle in March is as follows:—

Egg laid	1st March.
Egg hatched	7th ,,
Caterpillar full-fed and pupated	22nd ,,
Moths emerged	29th March to 3rd April.
One moth that emerged on 1st April laid 25 eggs on	3rd April.
7 ,, ,,	7th ,,
2 ,, ,,	9th ,,
and died ,,	11th ,,

A generation then takes from four to five weeks only and the increase is rapid. The number of eggs laid varies, as many as 86 being laid in one case.

The pest is an introduced one and evidently if it could be prevented from breeding in the seed potatoes, it would be very much, if not entirely, checked, as it apparently has no other food-plants in India but potato.

THE PUSA EXPERIMENTS.

The experiments at Pusa were done with a view of testing the ways in which seed-potatoes could be stored absolutely out

of reach of the pest. If the moth cannot get access to the tuber, eggs cannot be laid, and if at the time of storing the tubers are freed of eggs, there can be no attack nor can the pest breed.

Lots of 25 seers each of seed-potatoes were taken, picked over to see they were sound and stored; one series was in baskets, another on mats or bamboo machans; for each series, a lot was stored in lime, lime and kerosene, lime and naphthaline, ashes, charcoal, sand, sand and kerosene, sand and naphthaline, sand and crude oil emulsion, neem leaves; for each of these again, one lot of tubers was untreated, others were dipped in crude oil emulsion (one pint in four gallons of water), rosin compound (stock solution), copper sulphate (cold saturated solution), lime water, lead arseniate (1 lb. in 4 gallons of water). There were check lots untreated, and three lots were treated with formalin at the suggestion of the Imperial Mycologist. The potatoes were examined at intervals and the rotten ones weighed and destroyed; they were stored at the end of May, the sound ones remaining on the 15th October sown. As some of the lots had wholly rotted, only those giving a definite percentage were sown; of these an equal quantity (five seers) of each was sown with the ordinary potatoes in the farm and the yield of each lot was obtained. The experiment showed certain general conclusions before the actual yields of potatoes were obtained and these were acted on in the Central Provinces. The tubers keep better on mats or on the floor than in a basket, bag or heaped up. The best medium is sand, or sand and naphthaline, the next best charcoal; lime was good but the actual yield of potatoes from seed stored in lime was small; (this may have been simply experimental error). For dipping, lead arseniate, crude oil emulsion and copper sulphate are all good. Potatoes stored in ashes dry up at once and all perish in a short time.

The following table gives the results of those in which five seers out of twenty-five were available at the end of the storage period: in this table, the method of storage is shown, then the amount rejected between June 1st and October 15th, the amount left on that date (the difference being evaporation from the

potatoes), the yield per acre based on the actual yield of the plot, and the total yield that would have been obtained from the whole amount of seed left from the 25 seers stored :

Method of Storage.	Amount rejected.		Amount left on 15-X.		Yield per acre.		Yield from amount left.		
	S.	Ch.	S.	Ch.	Mds.	S.	Mds.	S.	Ch.
1. In lime in basket	9	8	10	4	51	32	1	38	0
3. Do. (19), Kerosene (1) in basket ...	10	12	9	7	44	12	1	24	0
5. In *neem* leaves in basket	10	5	9	11	53	5	1	20	0
8. In sand in basket	13	10	7	12	24	31	0	21	0
9. Do. 20, Naphthaline 1, in basket ...	15	7	6	4	4	17	0	3	4
12. Dipped in C.O.E. (1-32), in basket ...	10	3	7	11	33	8	0	37	0
13. Ditto in lime in basket ...	8	13	11	12	58	17	2	27	8
15. Ditto in sand in basket ...	9	5	11	6	81	0	3	18	0
20. Dipped in Cu S O_4, in basket	12	1	6	5	68	16	1	24	0
21. Ditto in lime in basket ...	8	8	10	10	72	15	2	35	0
23. Ditto in sand in basket ...	9	3	10	6	63	16	2	18	0
24. Dipped in lime sol., in basket	13	7	5	13	51	32	1	3	0
26. Ditto in sand in basket ...	12	8	7	10	79	27	1	27	0
27. Dipped in lead ars., 1-32, in basket ...	6	1	12	3	85	0	3	0	0
28. Ditto 1-32, in lime in basket	7	6	11	15	33	21	2	28	0
30. Ditto 1-32. in sand in basket	9	3	10	11	85	0	2	20	0
31. Untreated in basket	9	0	8	2	65	3	2	0	0
32. Ditto on mat	5	3	14	1	96	20	3	24	0
33. Ditto do. in sand	5	8	15	5	108	0	4	20	0
34. Ditto do. in sand and Naphth. ...	3	2	15	8	831	19	5	22	0
37. Ditto do. in charcoal	3	2	13	12	102	28	3	36	0
39. Dipped in lime sol., in sand	5	2	12	2	84	4	3	20	0
42. Ditto formol, ½%, 1 hour	7	0	10	8	49	5	1	0	0
43. Ditto formol, ½%, ½ hour ..	7	2	11	8	48	28	1	23	0
44. Ditto formol, 3%, 10 minutes ...	6	4	11	0	32	30	1	2	0

Trials in the Central Provinces.

Occurrence :—The pest has been reported from a large number of different places in the Central Provinces.

The crop is an important garden crop, and in certain areas where the conditions of climate, water and manure supply are all favourable, it assumes considerable importance in the local economy of that tract. For several years it had been stated that the potato crop at Chhindwara had been steadily and rapidly decreasing in area and importance, and the cultivation of this particular crop formerly so profitable seemed threatened with extinction. It was decided to make an enquiry into the cause of this reported decrease in area in 1908, and in the spring of that year visits were made to Chhindwara and several other important potato-growing centres for this purpose. The damage was speedily found to be due to the ravages of the potato-moth (*Phthorimœa*

operculella) a pest which attacks the tubers in store, eating away the eyes of the potatoes and rendering them useless for seed purposes.

Enquiry showed that the pest was widely distributed throughout the north of the province as it was reported from such widely separated places as Marwara in the extreme north-east corner of the Province, Khamla in the south-west on the Berar border, Saugor in the Vindhyan tract, and in fact from nearly every place where potatoes are habitually grown. It occurs also in the Nilgiris, Dharwar, Belgaum, Poona and in Patna; it has not been found in Naini Tal or other places in the Himalayas, nor in any place north of the Ganges.

The pest seems to have been introduced quite recently. In Chhindwara, cultivators have been accustomed to store their seed so long as can be remembered, and as the place was very isolated before the railway was opened five years ago, no fresh seed was, as a rule, introduced. The arrival of the pest seems to coincide so far as can be ascertained with the introduction of the round white Italian variety from Poona owing to the well-intentioned efforts of one of the District Officers a few years ago, who hoped thereby to raise the quality of this crop, as the local "moolki" variety had much deteriorated and fresh seed was needed. Within the last three or four years, cultivators state that they have been unable to keep their seed, as it all goes rotten in May and June, whereas formerly only 25 per cent. of the seed stored was lost, and it mostly went rotten during the rains from the attacks of moulds and similar fungi.

In Saugor, growers say that the moth first appeared about eight years ago. Before this, however, when a change of seed was required, one or two potato-cultivators were commissioned to purchase seed for all from Poona. They found, however, that the crop from Poona seed was of inferior quality and suffered from a disease which seems from all accounts to have been the ring disease (*Bacillus solanacearum*) which is still fairly prevalent there. As a result about eight or nine years ago, they decided to purchase their seed-potatoes direct from the ship in Bombay, and the moth seems to have been introduced with the

freshly imported seed which comes from Italy and the South Mediterranean. Saugor potatoes are imported to many parts of the province, and the pest was probably spread by this means to other important potato-growing centres.

Remedial measures were accordingly decided on last year. The preliminary experiments described above had indicated that the only possible means of combating the pest was to destroy the eggs on the tubers before storing them for seed, by steeping them in some solution which would kill the eggs without injuring the germinating power of the seed and then to store the seed so treated in baskets covering them completely with sand or lime to prevent a fresh generation of moths from depositing more eggs on the seed tubers.

The three solutions, which had given the best results in these preliminary trials, were crude oil emulsion, copper sulphate and lead arseniate paste. The last was discarded at once as being impracticable. In addition to being difficult to obtain in outlying villages, it is a virulent poison and accidents were very likely to occur if it had been distributed, as villagers are not particularly careful in carrying out the details of experiments and do not fully study the most careful instructions.

Copper sulphate is now sold in many country bazaars in certain districts as a remedy for smut in juar, but it often contains ferrous sulphate as an impurity which is likely to injure the seed, and the crystals have also to be pounded and dissolved to make the solution, an operation requiring some time.

Crude oil emulsion therefore was finally fixed on as the most suitable remedy. The emulsion is simply poured into the requisite proportion of water and stirred with a stick and the solution is ready for treating the seed.

In the trials made last year, crude oil emulsion was used at Saugor, Chhindwara, Pachmarhi and Hoshangabad, and the copper sulphate was tried at Hoshangabad alone and only on a small scale.

An account of the operations undertaken at these places will prove of interest.

At Saugor the spring crop ripens at the end of April or beginning of May. As many of the cultivators, who are chiefly *Kaethis* by caste, as possible were assembled and the mixture made before them and its ingredients and action explained. One and a quarter pounds (equal to one pint) of crude oil emulsion, was weighed into a shallow tub containg 4 gallons of water and the contents stirred with a stick. Sand was found by the assembled community in a nullah close by. The cultivators stated that they had given up their old custom of storing potatoes for seed as they had found in the last few years that it was always completely destroyed in the early rains, whereas before the moth came, the loss in storage was approximately a quarter. Fifty cultivators, however, volunteered to try the experiment with quantities of seed varying from 175 to 10 lbs. The seed was carefully hand-picked, steeped for five minutes in the solution, dried and stored in sand in baskets of two sizes, holding 25 and 50 seers respectively. The baskets were marked with a ticket giving the name of the tenant and weight of seed stored and each man was requested to keep a note of the date on which the tubers so stored were examined during the rains, as it was explained that the stored tubers should be examined at regular intervals and the rotten ones thrown out.

These last details as to examination during the storage period were not in every case properly carried out, but where regular examinations had been made the results were excellent. The tubers were stored on the 22nd and 24th May, and finally opened on the 4th to 6th September.

The results are shown below :—

Number of tenants.	Weight at storage in May.	Weight at opening in September.	Loss.	REMARKS.
	lbs.	lbs.	Per cent.	
42 ...	1,782	1,167½	36	Examined at least twice during storage.
8 ...	490	151½	69	Not examined after storage or lost from unavoidable causes.

In Chhindwara the potato crop ripens in March and potatoes were stored on the 7th of April 1909. The experiment was carried out by a large mali cultivator who is the head of all the malis in the neighbourhood, who besides cultivating a large area of garden land is also a member of the local Agricultural Association. He was also very sceptical of the efficacy of the treatment recommended, but when he understood that the cost of the treatment only came about one anna per maund and the tubers so treated remained good for culinary purposes he consented to a trial, and treatment and storage was undertaken before a large assembly of cultivators interested in the matter. The method employed was practically the same as at Saugor, but to simplify matters the solution was made a little weaker, one (whisky) bottle of crude oil emulsion being mixed with forty bottles of water in a galvanised iron tub and dried and stored as before. The mali examined his tubers three times during storage, rejecting the rotten ones. After the last examination in the middle of August, he kept the seed uncovered as he said that there was then no fear of the pest attacking the tubers.

The results at the time of planting on the 20th of September, *i.e.*, after 4½ months storage are stated below :—

Weight at storage in April.	Weight at planting in September.	Loss.
lbs.	lbs.	Per cent.
300	150	50

No signs of the pest were seen in the tubers that remained in September. Before this pest was introduced cultivators always counted on a loss of about 40 per cent. on storage due to attacks of fungi, etc., during the rains as the period of storage is longer here than at Saugor. These results have met with the greatest satisfaction in Chhindwara, and the mali has applied for sufficient crude oil emulsion to treat the whole of the seed potatoes for the neighbourhood next year, while neighbouring villages have asked to have the method demonstrated. The cost

of potatoes in Chhindwara after the crop comes into the market is thirty seers to the rupee, while the cost of seed potatoes in September-October at the time of planting is no less than ten seers per rupee from which it will be understood that this remedy, if widely adopted, will effect very considerable saving.

In Pachmarhi, cultivators could not be persuaded to carry out trials, but demonstrations were made in the public garden where it was necessary to store the seed from a crop of English potatoes which it was desired to propagate. The methods employed were similar to the above-mentioned instances, the strength of the crude oil emulsion being 1 pint in 4 gallons of water. Tubers were stored for nine weeks only and were opened out for planting in the first week of July.

Results are tabulated below :—

Weight of storage in April.	Weight left in July.	Loss.	REMARKS.
lbs.	lbs.	Per cent.	
464	425	8·5	Treated and stored.
70	50	28·5	Check experiment. Tubers not treated or stored.

When the potato-moth pest is absent, little loss occurs in Pachmarhi during the hot weather months, and the main loss is caused by fungi and moulds in the rainy season months. The godown in which the experiment was carried out was cleaner and afforded less refuge for moth than the ordinary cultivator's shelter and the loss from moth during the hot weather is probably more than 30 per cent.

On the Hoshangabad Farm last season trials on a small scale were made to ascertain the most convenient method of treating seed-potatoes. So far as they went, the trials indicated that the loss when copper sulphate is used as the steeping solution was comparatively greater than when crude oil emulsion was used. On the other hand, lime gave slightly better results than sand as a covering material, but taking into consideration the cost of lime in most parts of these Provinces and its inferior and uncertain quality, there seems little doubt that sand is the

most convenient and practicable material with which to cover the seed tubers after treatment.

For storing small quantities of seed-potatoes ordinary bamboo baskets are very convenient, but when large quantities of seed have to be handled the preliminary cost is rather excessive and the space required is great. These and other little difficulties connected with the use of baskets were pointed out by big growers at Saugor and Chhindwara. At Saugor two gons (1 gon = $3\frac{1}{2}$ mds.) were steeped in crude oil emulsion in the ordinary way. A bamboo mat was placed on the floor of the godown and covered with sand, a layer of potatoes was then laid down and covered with sand and another layer on the top, the whole being finally covered with sand. These tubers were stored for $3\frac{1}{2}$ months, but unfortunately were not looked at regularly and the upper tubers also got uncovered as care was not taken to keep the sand properly over them.

The results are, however, encouraging as a considerable saving of seed was effected and with a little experience a modification of this method should prove successful.

Weight at storing in May.	Weight remaining in September.	Loss.	REMARKS.
lbs.	lbs.	Per cent.	
560	180	67	Stored on bamboo matting in sand.

The natural wastage on storage in Saugor is about 25 per cent., and in this case the top layer of tubers suffered from attacks of the potato-moth caterpillar, as the protecting layer of sand was in places removed through carelessness.

In conclusion, it may be asserted that the results obtained are distinctly encouraging for one year's demonstration. The remedy is simple, cheap and efficacious and when potato-growers begin to realise the necessity for completely covering their seed with sand and regularly going over their stock in the rains in order to reject rotten tubers and prevent the spread of fungi, there seems little doubt that they will be able to combat this pest successfully.

THE EFFICIENCY OF THE "HADI PROCESS OF SUGAR MANUFACTURE.

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AND

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The experiments recorded in this article were undertaken to test the efficiency of the method of sugar boiling introduced some years ago by S. M. Hadi, Khan Bahadur, Assistant Director of Agriculture, United Provinces, and known as the "Hadi Process." Certain technical improvements on the old methods have made it very popular among land-holders, and others desiring to produce sugar directly from juice in an area with a limited supply of cane.

The process is too well known to need a detailed description in these pages, and has been fully described in Bulletin 19 of the Department of Agriculture, United Provinces. For the benefit of those who are not able to obtain the original memoir, it may be mentioned that it consists essentially in boiling the juice in a series of three open pans, arranged to work continuously over a furnace, in such a manner as to facilitate economy of fuel, and to produce the gradual heating necessary for the modified methods of clarification introduced by the inventor.

These modifications consist in adding small quantities of dilute Sodium Carbonate solution and the juice of *Hibiscus esculentus* to the gradually warming juice, and removing the scum by hand. It is an essential feature of the process, as at present practised, that lime is not used during the clarification. The use of lime has been advocated by many as likely to reduce the loss of sugar, and comparative trials on a large scale with limed and unlimed juices will shortly be undertaken by this Department.

The first thing to determine is the actual efficiency of the process as at present worked, *viz.* : How much of the sucrose that goes into the factory in the juice is obtained in a merchantable form in the first and second sugar, how much of it goes into the molasses and scum, and how much of it is inverted and destroyed during the process of the manufacture. The work of the department this year was confined to attempts to obtain satisfactory and reliable answers to these questions.

The factory selected by the Assistant Director of Agriculture for the test was situated at Baraon in the Karchana Tahsil of the Allahabad district. It belonged to Rai Ragho Prasad Narain Singh Bahadur, Thakur of Baraon, and to this gentleman we desire to offer our most hearty thanks. Without his help and co-operation the work could not have been carried out.

The factory was provided with a 3 roller mill by Messrs. Harris & Co. of the Napier Iron Works, Madras, driven by a 9-horse-power Hornsby oil engine, and capable of crushing 20 maunds of cane an hour. The rollers were 12 inches in diameter and 18 inches long. A steam driven centrifugal was in the course of erection, but it was not used for the experimental work. The latter was carried out with hand-driven machines, 18 inches in diameter, described in Bulletin 19 of the United Provinces Department of Agriculture.

The efficiency of factories using the process will vary within certain limits; the skill of the sugar boilers in this as in other processes of sugar manufacture is the important factor. There is every reason to believe that this factory is a typical one and that the figures obtained indicate an efficiency that can usually be expected.

The details of the actual working of the process were not interfered with, and were precisely what they would have been, if the experimental control had not been in progress.

The juice as it came from the mill was weighed, and sampled. In each sample the amount of sucrose, the amount of glucose,* and the specific gravity was determined by the methods, described

* The term "glucose" used in this article includes all reducing sugars.

by the authors in Bulletin 13 of the Imperial Department of Agriculture.

The juice was then taken into the evaporators and boiled into 'rab' (massecuite). The scum, removed during purification, was, after draining, weighed, sampled, and analysed at the end of each day's work.

The warm massecuite from the evaporators was stored in ghurras (bottle-shaped earthen vessels holding about 60lbs. of rab) until it was ready for centrifugating. The length of time that should elapse before massecuite produced by this process deposits a maximum amount of crystals varies, but it is considered by those experienced in the work not to be under 10 days.

The experimental boiling began on January 16th and ended on January 26th. The centrifugation of the first samples of massecuite commenced on January 28th, and continued until February 5th, approximately 500lbs. being worked up daily. Each day's yield of 1st sugars was air-dried, weighed, and a representative sample sent to the central laboratory for analysis.

The molasses from the 1st sugars were boiled into second massecuite, stored in ghurras, and allowed to stand 3 weeks before centrifugating. Finally, the second sugar and the molasses from the second massecuite were weighed, sampled, and analysed.

When massecuite is worked up into sugar, the ghurras in which it is stored are broken, and the massecuite scraped from the broken pieces. The scraping is, however, never complete. The small loss from this source was determined by weighing the broken ghurras, taking a representative sample, and estimating the glucose and the sucrose in it.

The operations recorded above afford the necessary data for determining the efficiency factor of the boiling process.

The investigation of the efficiency of the mill as indicated by the percentage extraction was not undertaken. It was deemed inadvisable to impose more quantitative experimental work on the staff than could reasonably be carried out. The efficiency of the mill is of course a most important point in the economical working of the factory and should be determined whenever a new mill

is erected, but it does not affect the question of establishing an accurate control of the boiling process.

The composition of the raw juices used during the 10 days experimental boiling is given in Table I.

TABLE I.

Composition of the Raw Juice.

No.	Weight.	Sucrose.	Sucrose.	Invert Sugar.	Invert Sugar.	Glucose Ratio.	Specific Gravity.	Total Solids.	Purity co-efficient.
.	lbs.	Per cent.	lbs.	Per cent.	lbs.			Per cent.	
1	689·0	15·51	106·8	1·35	9·3	8·7	1·0814	19·6	79·1
2	712·0	. 14·59	103·8	1·43	10·2	9·8	1·0780	18·8	77·6
3	722·0	13·63	98·4	1·56	11·2	11·4	1·0733	17·8	76·5
4	781·0	13·81	107·8	1·59	12·4	11·5	1·0747	18·1	76·3
5	724·2	15·00	108·6	1·50	10·8	10·0	1·0797	19·2	78·1
6	691·0	14·82	102·4	1·40	9·7	9 4	1·0788	19 0	78·0
7	631·5	15·20	95·9	1·33	8·4	8·7	1·0794	19·1	79·5
8	665·0	14·91	99·1	1·27	8·4	8·5	1·0790	19·0	78·4
9	648·2	14 73	95·4	1·33	8·6	9·0	1·0783	18·9	77·9
10	639·5	15·51	99·1	1·21	7·7	7·8	1·0811	19·5	79·5
11	1,106·5	16 45	182·0	1·13	12·5	6·8	1·0826	19·8	83·0
12	1,483·7	13·40	198·8	1·23	18·2	9·1	1·0685	16·7	80·0
13	709 2	14·00	99·2	0·73	5·2	5·2	1·0676	16·5	84·8
14	740·0	14·69	108·7	0·65	4·8	4·4	1·0710	17·3	84·9
15	967·0	14·31	138·3	0·78	7·5	5·4	1·0697	16·9	84·6
16	724·7	14·50	105·0	0·81	5·9	5·5	1·0705	17·1	84·7
17	976·5	14·62	142·7	0·94	9·2	6·4	1·0724	17·5	83 5
18	896·0	15·19	136·1	1·10	9·8	7·2	1·0763	18·4	82·5
19	723·0	14·89	107·6	0·78	5·6	5 2	1·0739	17·9	83·1
20	742·0	15·20	112·7	0·82	6·1	5·3	1·0756	18·3	83·0
21	753·5	14·46	108·9	0·82	6·2	5·6	1·0729	17·7	81·6
22	744·0	15·61	116·1	0·89	6·6	5·7	1·0773	18·7	83·4
23	1,391·5	14·84	206·5	0·76	10·6	5·1	1·0739	17·9	82·9
24	495·7	14·75	73·1	0 82	4·0	5·5	1 0732	17·8	82·8
25	726·0	14·88	108·0	0·75	5·4	5·0	1·0744	18·0	82·6
26	986·5	14·83	146·3	0·76	7·5	5·1	1·0744	18·0	82·3
27	736·0	16·07	118·3	0·81	5·9	5·0	1·0795	19·2	83·7
28	740·0	16·21	119·9	0·82	6·0	5·0	1·0796	19·2	84·4
29	747·0	15·91	118·8	1·15	8·6	7·2	1·0801	19·3	82·4
30	745 0	15·58	116·1	1·29	9·6	8·2	1·0800	19·3	80·7
31	742·0	15·43	114·5	1·45	10·7	9·3	1·0800	19 3	79·9
32	743·5	16·69	124·1	0·70	5·2	4·1	1·0827	19·9	83·8
33	752·2	16·25	122·2	0·70	5·2	4·3	1 0803	19·4	83·7
34	753·5	17·13	129·1	0·87	6·5	5·0	1 0857	20·5	83·5
35	985·5	16·83	165·6	0·87	8·6	5·1	1·0828	19·9	84·5
	28,013·9	15·12	1235·9	1·02	288·1	6·6	1·0765	18·5	81·7

The sucrose varies from 13·40% to 17·13% and glucose from 0·65% to 1·59%.

It is a well-known fact that the amount of crystallisable sugar obtainable from massecuite is very considerably influenced by the quality of the juice from which it is made. A comparatively small increase in the amount of glucose in the juice

causing a considerable diminution in the quantity of crystalline sugar, obtained from the massecuite, and a proportionate increase in the amount of sucrose lost in the molasses.

The experiments this year afforded an opportunity of practically demonstrating this important point. The examination of the raw juices (Table I) showed that the earlier samples were poorer in quality as sugar producers than those examined towards the end. The actual percentage of sucrose was not much less, but they contained larger amounts of glucose and other solids in solution, which prevent sucrose from crystallising; that is to say, they had high glucose ratios and low purity co-efficients.

The method of storing rab in small ghurras enabled us to centrifugate separately the massecuite from the different samples of juice, and to correlate the yield of sugar and molasses with the composition of the juices.

TABLE II.

Date of boiling.	Date of centri-fugating.	Per cent. air-dried Sugar in massecuite.	Per cent. Molasses in massecuite by difference.	Average % of Sucrose in Juice.	Average % of glu-cose in Juice.	Glucose Ratio.	Average Purity co-efficient.
16-1-09	28-1-09	21·0	79·0	14·55	1·44	9·9	77·8
16-1-09 } 17-1-09 }	29-1-09	28·7	71·3	14·67	1·46	9·9	78·0
17-1-09 } 18-1-09 }	30-1-09	30·9	69·1	15·55	1·21	7·7	80·0
19-1-09	31-1-09	33·2	66·8	13·40	1·23	9·1	80·0
20-1-09	{ 31-1-09 1-2-09	36·9	63·1	14·56	0·86	5·1	84·1
21-1-09	2-2-09	36·7	63·3	15·04	0·82	5·4	83·0
22-1-09	3-2-09	36·8	63·2	14·83	0·76	5·1	82·8
24-1-09	4-2-09	37·1	62·9	15·83	1·10	6·9	82·4
25-1-09 } 26-1-09 }	5-2-09	36·2	63·8	16·72	0·78	4·6	84·0

Table II shows the percentage of 1st sugar and molasses in the massecuite, and the average composition of the juice from which it was made. Low yields of crystalline sugar always accompany high glucose ratios and low purity co-efficients.

To take two examples, the juice boiled on the 16th & 17th January contained 1·46 % of glucose. Its glucose ratio was very high, *viz.*, 9·9 and its purity co-efficient low, *viz.*, 78. The massecuite yielded 28·77 % of sugar crystals when it was

centrifugated. The sugar was badly grained and difficult to handle. The juice boiled on 22nd January contained 0·76 % glucose, the glucose ratio was much lower 5·1, and its purity co-efficient high, *viz.*, 82·8. The massecuite yielded 36·8 % of crystalline sugar, nearly 8 per cent. more than that obtained from the poorer quality juice. The percentage of sucrose in both juices was almost the same = 14·67 in one, and 14·83 in the other. This may make all the difference between profit and loss in working a factory.

The canes of Northern India contain a higher percentage of glucose and impurities in solution than those of other countries, and the results contained in Table II bear out the author's contention in a previous publication, that the first efforts to improve the cane of these provinces, from a sugar manufacturer's point of view, should take the form of selecting and cultivating varieties, which ripen uniformly and at the required time, and which yield a pure juice, *viz.*, one with a high purity co-efficient, and a low glucose ratio. This is just as important when sugar is made indirectly from gur, as when it is made directly from cane.

The weight and composition of the products :—1st and 2nd sugars—final molasses—1st and 2nd massecuite—and the ghurra waste are given in Table III. The weight and composition of the scum in Table IV.

TABLE III.

Composition of 1st Sugar.

No.	Weight.	Sucrose.	Invert Sugar.	Sucrose.	Invert Sugar.
	lbs.	Per cent.	Per cent.	lbs.	lbs.
1	53·5	92·76	1·16	49·62	2·22
2	152·5	96·44	1·10	147·07	1·67
3	77·0	91·18	3·43	70·20	2·64
4	164·5	94·24	2·08	155·02	3·42
5	96·5	93·50	2·38	90·22	2·29
6	90·5	93·64	3·06	84·74	2·76
7	162·0	96·54	1·41	156·39	2·28
8	200·5	96·70	1·16	193·88	2·32
9	225·0	95·01	1·59	213·77	3·57
10	125·0	94·85	2·32	118·56	2·90
11 & 12	431·0	95·93	1·34	413·45	5·77
.	1778·0	95·16	1·79	1692·92	31·84

Composition of 2nd Sugar.

1	753·5	86·89	6·42	654·7	48·4

Composition of Final Molasses.

1	2312·5	35·92	20·30	830·6	469·4

Composition of 1st Massecuite (1st Rab.)

1	5205·5	67·86	10·4	3532·4	541·4

Composition of 2nd Massecuite (2nd Rab.)

1	2539·5	56·68	19·89	1439·4	505·1

Composition of Ghurra Waste.

1	802·75	6·03	1·91	48·4	15·3

TABLE IV.

Composition of Scum.

No.	Weight.	Sucrose.	Glucose.	Sucrose.	Glucose.
	lbs.	Per cent.	Per cent.	lbs.	lbs.
1	28·2	14·60	......	4·1	......
2	64·5	16·80	......	10·8	......
3	39·8	12·08	......	4·8	......
4	61·5	13·76	2·20	8·4	1·35
5	49·7	24·52	4·92	12·1	2·44
6	105·0	14·74	1·56	15·5	1·63
7	45·0	14·82	1·74	6·6	0·78
8	81·0	15·42	1·11	12·5	0·89
9	129·0	16·46	1·28	21·2	1·65
10	112·5	19·92	1·98	22·4	2·22
11	175·0	23·20	2·23	40·6	3·90
12	147·0	16·50	1·60	24·3	2·35
13	44·0	13·48	1·04	5·9	0·45
14	52·5	14·14	1·69	7·4	0·88
	1134·7	17·32	......	196·6	......

28014 lbs. of juice yielded 1778 lbs. of air dried 1st sugar.
753·5 lbs. ,, 2nd sugar.
2312·5 lbs. of molasses.

This expressed as percentage of the juice is—

Air dried 1st sugar ... 6·3 % of total juice.
Air dried 2nd sugar ... 2·7 % ,,
Final molasses ... 8·2 % ,,

The percentage of juice extracted by the mill used at Baraon was not determined at the time of the control of the boiling process for reasons already stated. Experiments have indicated that not more than 60—65 per cent. of juice can be extracted. The yield of sugars and molasses expressed as percentage of cane, on the assumption that the juice represents 65 per cent. of the cane worked, is as follows :—

Air-dried 1st sugar	... 4·10	per cent. of the total weight of cane.
Air-dried 2nd sugar	... 1·76	,, ,, ,,
Molasses	... 5·35	,, ,, ,,

The total amount of merchantable sugar is slightly less than 6 per cent. of the total weight of cane.

A résumé of the yields and losses of sucrose is given in Table V.

TABLE V.

Total juice boiled in lbs.	Total lbs. Sucrose in juice.	Total lbs. Sucrose 1st Sugar.	Total lbs. Sucrose in 2nd Sugar.	Total lbs. Sucrose in final molasses.	Total lbs. Sucrose lost in Scum.	Total lbs. Sucrose lost in ghurra in waste.	Total lbs. Sucrose invested & destroyed during manufacture.
28014	4235·9	1692·9	654·7	830·6	196·6	48·4	812·7

The yields and losses of sucrose calculated as percentages of the total sucrose (4235·9 lbs.) that passed into the evaporators in the juice are as follows :—

Per cent. of total sucrose in 1st sugar	...	39·9
,, ,, ,, 2nd sugar	...	15·5
,, ,, ,, Final molasses	...	19·6
,, ,, ,, Scum	...	4·7
,, ,, ,, Ghurra Waste	...	1·1
Per cent. total sucrose inverted and destroyed	...	19·2
Manufacture	...	100·0

The yields and losses of sucrose calculated as percentage on the total weight of juice worked up are given below :—

Sucrose in 1st sugar per cent. juice	...	6·05
,, 2nd sugar ,,	...	2·35
,, Molasses ,,	...	2·96
,, Scum ,,	...	·60
,, Ghurra Waste ,,	...	·17
Sucrose in inverted and destroyed in the process of manufacture per cent. juice	...	2·90
Total Sucrose per cent. juice	...	15·12

For every 100 lbs. of sucrose that goes into the factory in the juice, 55·4 lbs. is obtained in merchantable form in the final sugars, 39·9 in the 1st sugar and 15·5 in the 2nd sugar. The efficiency factor of the boiling process is therefore 55·4.

The principal loss is by inversion and destruction of sucrose during the boiling of the juice into 1st massecuite, and the 1st molasses into 2nd massecuite. This loss cannot be determined directly, because not only is the sucrose inverted, but a considerable portion of the invert sugar is caramelised and charred, and cannot be traced analytically. The best way to estimate the loss by inversion and destruction is to determine, with the greatest accuracy possible, every other loss, and to take the difference figure. This is comparatively easy in a plant handling small quantities of juice, where losses of any magnitude such as spilling the juice on the way to the pans, can be prevented. The figure 19·2 representing percentage of total sucrose lost by inversion and destruction during boiling includes the small mechanical losses, which occur during the carriage of the juice from the mills, and the removal of the finished sugar from the centrifugating machines. These are very small, and certainly do not exceed 1 or 1½ per cent.

The amount of inversion and loss during evaporation is large, and is, to a certain extent, the result of using raw and acid juices. The efficiency of the process would be increased, if some suitable

method of neutralising the acids of the juice could be devised, although boiling sucrose in open pans would always give rise to considerable decomposition.

Good results have not been obtained by workers in these provinces by neutralising the juice with quick lime; dark massecuite and low quality sugar are said to be produced. It is possible that this is due to using very much more lime than is necessary for neutralisation. Further experiments are, however, desirable before a final decision is given on the merits of liming.

Sodium carbonate, which is employed at present, to partly neutralise the acids is unsuitable, because the sodium salts of the neutralised acids are left in solution, hinder the crystallisation of the sugar, and increase the amount of molasses.

It is suggested that finely ground carbonate of lime would be a suitable neutralising medium, because it would not form the objectionable compounds with sucrose, that cause the dark-coloured massecuite, when a slight excess of lime is used. There would, moreover, be no danger in using excess of it, as it is insoluble in water. The only disadvantage would be the filtering through cloth, necessary as the juice passes from the clarifier to the evaporator.

The sucrose lost in the scum amounts to nearly 5 per cent. This loss is avoidable, and could be reduced to certainly not more than one per cent. by the use of suitable filtering apparatus.

It is difficult to obtain figures of the efficiency of other processes, to compare with those given in this bulletin. These are not generally published by such factories as obtain them. As far as the authors are aware, none have been published in India.

The authors have been able to refer to comparative results of efficiency published in the West India Bulletin,* and to the factory results of 10 seasons' work in Java.†

* Central Factories for the West Indies by William Douglas, F.I.C., F.C.S. West Indian Bulletin, Vol. I, page 43 (The authors are indebted to Mr. B. C. Burt, B.Sc., I.A.S., for the loan of this literature).

† Statistics of Factory results on a number of Java Sugar Estates by H. C. Prinsen Geerlegs. International Sugar Journal, No. 127; Vol. II (July, 1909), 324.

These indicate the results achieved by other processes, and are compared with those obtained at Baraon in Table VI.

TABLE VI.

Comparison of the efficiencies of different processes of boiling and clarification.

Sucrose recovered per 100 Sucrose in juice in	Hadi Process open pan boiling. (Allahabad).	West Indian Muscavado Process (open pans).	Hawaun Factory Triple effect vacuum evaporation and carbonation.	West Indian Central Factory Evaporation in Oacus.	Results of 95 factories in Java, 1907.
First Sugar ...	39·9	67·75	89·91	72·4	89·91
Second Sugar ...	15·5			9·9	
Molasses ...	19·6	17·75	5·36	11·9	9·25
Inverted and destroyed in manufacture.	19·2	14·50	3·55	4·6	
Scum and waste ...	5·8		1·18	1·2	0·84
	100·0	100·0	100·0	100·0	100·0
Efficiency factor (per cent. total Sucrose recovered).	55·4	67·75	89·91	82·3	89·91
First Sugar recovered per cent. cane.	4·10 (Pol. 95·1)	7·15 (Pol. 90·0)	10·40 (Pol. 96·5)	8·60 (Pol. 96·5)	10·09 (Pol. 97·8)
Second Sugar recovered per cent. cane.	1·76 (Pol. 86·9)	... ..	3·19 (Pol. 90·0)	1·26 (Pol. 90·0)	...
Total Sugar	5·86	7·15	13·59	9·86	10·09

These figures are not brought forward to minimise in any way the important part played by the process under review in the revival of sugar-making in India. They indicate, however, the kind of competitors that have to be faced in developing the industry in this country. The efficiency of open pan boiling employed in the Hadi process cannot hope to approach that obtained with modern plant employing vacuum evaporation, but it should not be criticised too severely from this point of view alone. It must be remembered that it enables sugar to be manufactured in places with a limited supply of cane where

without it none would be made. The point to be careful about is to see that it is confined to its proper sphere, that is, working up small quantities of juice; and not employed in large factories where other forms of plant would be more efficient.

It will be seen from Table VI that factories in other countries with the most improved and up-to-date methods of manufacture are stated to be able to recover more than 80 per cent. of the sucrose in the juice as a merchantable commodity. In the Java results for the 10 years 1899—1908, already referred to, the average was 89·2 with a juice of purity varying from 83·3—88·66.

These factories have the advantages of experienced and skilled management, and the latest machinery; and they work on juice of somewhat higher purity than are produced in this country. It is not likely that factories established in India would show such a high efficiency continuously, at least not until considerable improvements have been made in the purity of the juice, and its glucose content lowered. An efficiency of 70—75 per cent. could, however, reasonably be expected with the juice at present available.

It is generally conceded that large central factories, of the type erected in Java and Hawaii, to work directly from juice, have little chance of success in Upper India; one of the reasons being the scattered distribution of the cane crop.

There is, however, no reason as to why a small and efficient plant working from 100—200 acres of cane season, and employing vacuum evaporation and improved methods of clarification, should not be a success. The difficulty at present seems to be as such a plant has not hitherto been required. None are on the market, and consequently the initial cost of designing and erecting it would be somewhat prohibitive; moreover, there are no trained men available at reasonable wages to work it.

One of the most useful lines of work that could be taken up by the Agricultural Department would be the experimental working of a plant of the type indicated above, and, if successful, training men to manage it.

The authors desire to take this opportunity of thanking their colleagues, Khan Bahadur S. M. Hadi and Syed Zamin Husain, for the valuable assistance afforded in obtaining the results recorded in this article.

AGRICULTURE IN THE KACHIN HILL TRACTS, BHAMO DISTRICT.

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I. *Area, Situation and Elevations.*—The Kachin Hill Tracts of the Bhamo District comprise an area of about 2,000 square miles, bordering upon the Chinese frontier, to the north of the Shan States—between the degrees of latitude 24·45 and 25·30, and of longitude 97° to 98°. The whole of the tract is very hilly—apart from the terraces, the areas of level or nearly level land being very small indeed and confined to very small patches scattered here and there in the deep valleys throughout the hills; or to somewhat larger areas bordering upon the large streams or rivers; which, for a great part of their course, however, flow rapidly between high banks or through deep gorges.

The elevation above sea-level runs from about 500 feet to 6,000 or 7,000 feet; some of the highest points rising somewhat abruptly to as much as 8,000 feet.

II. *Climatic Conditions.*—The rainfall varies from about 130″ to 197″. The variation of temperature from place to place according to the elevation, is very considerable. Even in the lower elevations the winter temperature is low, whilst frost and strong winds are very common in the higher regions. In sheltered valleys, frost often occurs as low as 2,500 feet elevation.

III. *Soils.*—The surface is frequently covered with rocks and breccia, and the soil for the most part is of a poor light, sandy nature, containing little or no organic matter and of a reddish colour. The slopes are generally very steep, though they vary considerably, and in the absence of vegetation the surface soil with any small amount of organic matter it may contain, is

easily washed away. These steep slopes (often rising at an angle of 80 degrees or even 90 degrees from the horizontal), as well as the more gentle ones, are largely under "Taungya" cultivation, which is carried out under what appear to be almost impossible conditions. One kind of soil apparently differing from the above only in being of a much brighter, rusty red colour appears to possess exceptional fertility, being capable of producing 8 or 9 crops of paddy in successive years: after which it is left fallow for another period of 8 or 9 years; not on account of any great exhaustion of the soil, but because, after 8 or 9 crops, the paddy is said by the cultivators to develop a bitter taste. This kind of soil exists on what is known as the Palaung ridge, and on many of the similar less elevated ridges and slopes towards the east of tract near the Chinese frontier.

The soil in some of the valleys is very rich, of a dark brown colour and easily worked, but these valleys are nowhere very wide and the area of such soil is strictly limited.

IV. *The People and their Habits of Living.*—(Information obtained largely from D. W. Rae, Esq., E.A.C., Assistant Superintendent, Kachin Hill Tracts). There are many different tribes of "Kachins" or "Chinpaws" as they call themselves, but their habits of living and systems of agriculture are much alike and may be described as one. There are, however, living in the same district, other tribes who practise somewhat different methods. These latter live in villages apart from the Kachins; but from our point of view, only one of them is of any great interest, namely, the "Yawyin" or "Lishaw" tribe, a mountainous race, inhabiting for the most part the highest ridges and practising a most destructive system of taungya cultivation.

The Kachins are supposed to have been in possession of these hills for a period of less than 100 years, but previous to that time the "Palaungs," a less warlike race driven out by the Kachins, obtained a livelihood largely by taungya cultivation, in much the same way as the latter race does at the present day. It is not known for what period the Palaungs held possession of the country, hence it is impossible to say how long this system of

agriculture has here been carried out, but it seems probable from the appearance of the country and the growth of vegetation that it has been continued for several centuries. The Kachin builds himself a comparatively large house with a low grass-thatched roof, the eaves of which almost touch the ground. The roof generally projects at both ends beyond the living room or rooms of the house, and under the shelter so formed his cattle, fowls and pigs are enclosed or find protection from the elements. These permanent houses built on flat or levelled pieces of ground are roughly grouped together in small villages in suitable, sheltered, accessible places, where there is a good water-supply on the sides of the hills, and a village or house is rarely removed.

The bread-winner of the family, however, does not usually live here throughout the year. At the time of cutting and burning his taungya (always within the jurisdiction of his village but often at a long distance from it), he builds for himself a small hut in which he lives until his crop has been harvested, after which he returns to his village for the remainder of the year.

METHODS OF CULTIVATION.

I. *Taungya Cultivation* is practised by all the hill tribes and is the chief means of subsistence, but the Kachin alone appears to carry out his cultivation in a systematic manner. The area at the disposal of any Kachin village is often roughly divided into the requisite number of blocks according to the length of the rotation—each block being cultivated in turn.

Taungya cutting takes place during the dry weather about the month of March. The cultivator, after cutting down the trees, shrubs and other growth, clears a strip all around the area to act as a fire-guard to the adjacent areas and sets fire to the dried brushwood. The trees are not, as a rule, cut off quite near the surface of the ground, but stumps projecting 2 or 3 feet above ground are left. Very little actual cultivation is carried out and cattle are seldom used for this purpose, though on the more accessible slopes a rough harrow drawn by buffaloes or bullocks is made use of. The seed is usually sown during the early rains by

dibbling into small "pockets" of soil loosened by the aid of a hoe or mamootie—the distances apart of the pockets and the number of seeds varying with the different crops sown. The after-cultivation is also very slight and consists of rough weeding and loosening of the surface soil by means of the hoe or mamootie. In reaping a good deal of the straw is left as stubble on the ground.

Rotations in Taungya Cultivation.—No definite rules of rotations are followed, but it is very seldom that more than two crops are taken off a piece of land before it is again allowed to lie fallow. A common practice at elevations below 2,500 feet is to grow the first year a crop of cotton and the second year a crop of paddy. The land is then allowed to return to its jungle state during a period varying from 7 to 12 years. At elevations above 2,500 feet, one crop only is taken, usually paddy or maize, though in favourable aspects two crops may be taken. When left fallow, the taungyas in some places rapidly become clothed with small trees and shrubs, but in other parts, especially at the higher elevations, this does not take place; but there arises instead, a dense growth of bracken and coarse grass, which not only prevents the seedlings of trees from becoming established, but, as it dies off each year and becomes very dry, causes enormous areas to be annually burnt over. This state of things exists over large areas on many of the higher hills, especially those formerly occupied by the Yawyins. As a means of preventing this a few villages in the more densely populated parts of the district have adopted the plan of sowing the seeds of trees or shrubs along with their crops of paddy. The seed selected is that of quick-growing species of Alder (*Alnus nepalensis*), called by them "Maibao," which reproduces very rapidly indeed and will grow specially well at these high elevations. This plan not only ensures a rapid covering of the ground but tends to shorten the rotation, which to the Kachins is of no small importance as the population becomes more dense.

One other rotation previously remarked upon should be here noted, namely, the 16 to 18-year rotation carried out on the Palaung ridge and other places near Lwejé. This is believed to

be rendered possible by the particularly fertile soil which, though it differs very little in appearance from most other soil of the region, is said to be capable of producing 8 or 9 crops of paddy in succession, after which the grain becomes bitter and unfit for food. After a rest of 8 or 9 years during which only tall, coarse grasses seem to flourish, the land becomes again suitable for cropping. If the cultivators' statements are correct, this will be an interesting problem for investigation. Most of the Eastern slopes on which this occurs are absolutely devoid of trees or shrubs, but are burnt off and cultivated in the same way as ordinary taungyas, except that a plough is usually made use of. Cultivation is begun in good time and is well carried out.

With the Yawyins or Lishaws the method is somewhat different. Taungyas are often burnt without previous cutting, *i.e.*, with the trees standing upright, and no fire-belt is made for the protection of surrounding areas. They do not adopt any method in their cultivation, but each man appears to burn his taungya when and where he feels inclined. The result of this is, that enormous areas not required for sowing are often carelessly burnt down, and to this system is generally attributed the great damage to forests done within the region occupied by this tribe. Enormous areas are now covered with bracken and coarse grasses as already described. Though the area occupied is large, the tribe is a small one and consists of some 18 small villages, and a total of 62 families. As they generally occupy only the highest and steepest parts of the hills, they do not, as a rule, grow any cotton or much paddy, but confine themselves largely to the cultivation of maize and a kind of small grained buck wheat called "Shari Mam."

In the Lapye Kha valley the following rotation is often practised, *viz.*, the first year after burning a "Ya," maize is sown, the second and third years "Shari Mam," the fourth year opium, after which it is left fallow at least 10 years. If the soil happens to be good, the rotation may be lengthened by growing opium for 3 or even 4 years in succession before the land is left fallow.

II. *Terrace Cultivation*—In some parts the area under terraces is considerable, and this system of cultivation, which is being encouraged, seems to be growing in favour among the villages possessing land which is not too steep. Some of the finest valleys are now terraced almost throughout, and in many places along the border they are cultivated by the transfrontier tribes or by the Chinese. In the lowest parts of the valleys the soil on these terraces is often extremely fertile; but in this region such soil is very limited and by terracing the steeper hill-sides, where the surface soil is extremely thin, the subsoil is exposed with the result that for a long time very poor crops only are obtainable. The labour is also very great and consequently the lazy Kachin seldom undertakes the work unless forced by necessity to do so. Moreover, "the Taungya" is necessary for certain "Nat" festivals or ceremonies; hence terrace cultivation is unlikely to entirely replace this method.

Paddy is the only crop grown on terraces to any great extent. The cultivation is generally done by cattle, though on narrow terraces it often has to be done by hand. It is often irrigated from some small stream or freshet running near by. The yield—except in the bottom of the valleys—is generally very poor—often on the newly-formed terraces not more than the yield from a taungya. In several places the figures obtained were 5 to 6 baskets of coarse paddy per acre. The paddy called "Tagu" grown on the terraces is generally of poor quality but slightly superior to the taungya paddy called "Shay Shang." The terraced land is, as a rule, cropped every year and never left fallow. The Yawyins and other inhabitants of the more elevated regions do not adopt this method of cultivation.

III. *Garden Cultivation.*—Almost every permanent Kachin household has its small patch of garden, from a few square yards to half an acre in extent, adjacent to the house. It is surrounded by a strong fence and is very frequently situated on the lower side of the house, so that the cattle manure is readily swept from the shed, through a hole in the fence, into the garden. In fact, it frequently happens that the urine and liquid part of the manure

flow from the hardened floor into the garden. This manure is but roughly spread, the greater part of it remaining near the house, but the garden soil soon becomes very rich. Cultivation is carefully carried out by hand and good garden crops are obtained.

Crops Grown.—The chief crops are as follows :—

I. *Paddy* is the chief crop grown on taungyas and on the terraces, but unless the aspect is very favourable it does not grow well at altitudes over 5,000 feet. The cultivator says that it is too cold. The varieties grown are very coarse. On taungya it is dibbled in, and on terraces it is either sown broadcast or transplanted—generally the latter. The yield is small, the markets are local and the price low. The difficulties of transport prevent exportation to better markets. It is one of the chief food crops, but is also used by the Kachins for making Kachin beer ("Cha krat cherru"), which is flavoured with ragi.

II. *Maize* is grown for local consumption—largely by the Yawyins at the higher altitudes ; but also by the Kachins. It is dibbled on taungya land.

III. *Buck Wheat* (called "Shari Mam") is grown on taungyas by the Yawyins in the highest regions only. The grain is very small—not more than half the size of the European variety. It is used as a food crop for making cakes, but also largely for making liquor.

IV. *Ragi* is grown by the Kachins in small quantities for flavouring their liquor ("Cha krat cherru") and *Setaria italica* is also sometimes grown for the same purpose. They are sown on taungya lands.

V. *Beans and Peas* are grown throughout these hills, but not in very large quantities. They are dibbled on taungya lands generally with some other crop, such as maize, which acts as a support for the bean plants. They are often sown alongside fences or tree stumps, which also act as supports. The market for these is also mostly local, though some of them are frequently to be brought in the Bhamo bazaar under the name of "Kachin

pé." Here again the export is prevented by the difficulties of transport. The following are a few of the chief varieties found growing here:—

(a) *Dolichos lablab* ("Praing lep" (Kachin).

(b) *Phaseolus calcaratus* ("Ning-Krung-Shapré").

(c) *Phaseo vulgaris* ("H' Krain-u-Shapré").

(d) *Faba vulgaris* ("Sán dū-Si"), very probably introduced lately.

(e) *Glycine hispida* ("Lazi-Shapré-Tum or Nga-si").

(*f*) *Pisum sativum* ("Sán-too-si).

VI. *Cotton* is grown in the foot hills up to about 2,500 feet high. The first crop after burning a taungya is generally cotton, which is followed by paddy the next year. It is dibbled in the same way as for the other crops. The fibre is short in staple and somewhat coarse. The seed cotton before ginning sells at about 15 lbs. per rupee and any not required for local consumption appears to be carried across the frontier into China, but the total produce is at no time very large.

VII. *Poppy Cultivation* is carried out in small patches. The seed is sown broadcast, either on taungya land or on a patch of permanently cultivated ground near the village.

On taungyas it is generally an additional crop in the rotation, being sown the year after the main crop (or the second main crop as the case may be), has been taken off. It grows well, but as the export of opium is prohibited, sufficient for home consumption only is grown.

VIII. *Tobacco* is cultivated on the light soils of some of the valleys, especially the Lwejé valley, where it is said to grow luxuriantly on the red soils without manure. It is sown and planted out on drills in the ordinary way.

IX. *Mustard, Yams, Sweet Potatoes,* and a variety of cucurbitaceous fruits are also grown on taungyas—usually mixed with the main crop—and at low elevations chillies are sometimes cultivated as a separate crop.

X. *Potatoes* grow well as a garden crop, and fruit trees, especially peaches, are to be found around most villages—the

result of their distribution by the Assistant Superintendent. They, however, receive scant attention and the produce is, as a rule, very poor.

XI. *Wheat and Barley* are newly introduced crops, which have been sown under the direction of the Assistant Superintendent—in school gardens or by a few selected cultivators, in several of the chief villages. With wheat, and in one place with barley, considerable success has been attained.

Oats were also tried in the same way, but with very indifferent success.

The Implements used are of the simplest kind and differ only very slightly from those used in Burma proper. On the lower levels, the terraces and the gentler slopes, either the single-buffalo plough or the double-buffalo plough may be used; but in many places all the cultivation is carried out by hand with the aid of a kind of hoe or mamootie. As in the case of most other hill tribes, every Kachin carries his "dah" or large, heavy-bladed knife in a kind of sheath slung over the shoulder. The blade is usually about 18 inches long and broader and heavier at the end than near the handle. It is ever ready to be used for cutting, digging or any other kind of work to which it can be applied.

Cattle, etc.—Buffaloes are largely used in the valleys for cultivation, and command a high price around the chief paddy-producing tracts, as for example, near Lwejé and in the Maubong valley, which is worked almost entirely by the Chinese, though part of it only is Chinese territory. In these valleys cultivation is very carefully carried out, the land being turned up in large lumps in order to induce aëration a long time before it is required for planting. The value of this operation appears to be fully recognized by the cultivators.

Buffaloes are also made use of in certain "Nat" ceremonies. Bullocks are sometimes used for cultivation, but are very largely used as pack animals. Though slower than mules, asses or ponies, they are cheaper and serve the purpose very well on the steep hill paths. As the Kachins do not drink milk, cattle are

not kept for milk production, though breeding and rearing are carried out in most places.

Pigs are reared in all places—sometimes very largely. They are allowed to run wild around the villages, feeding on wild plants, roots and offal, but they are also fed on a kind of paddy meal (simply paddy ground-up without husking), mixed with a large quantity of water.

Manuring is very little practised, except as above described, on the garden lands attached to the houses. In some of the larger villages, however, the droppings of pigs and cattle are said to be collected and applied to the land.

Transport of Produce is one of the chief difficulties. Owing to the absence of roads—except narrow paths cut along the hill-sides, all goods, produce, etc., have to be carried on pack animals. Asses, mules, ponies and bullocks are made use of for this purpose. Consequently only the least bulky and most valuable produce can be profitably transported to Bhamo or other marketing centre.

THE CONSTRUCTION OF COW-HOUSES.*

By JOHN SPEIR, Kt.St.O.

The requirements of modern life demand a degree of purity in our food supplies little dreamt of in previous generations. Milk is no exception to the general rule, and in order to obtain pure milk it must be produced by healthy cows in healthy surroundings.

In the construction of houses for the accommodation of cows intended to produce milk, either for consumption as it comes from the cow, or to be made into cheese or butter, the main requirements to be kept in view are the following :—

(1) The milk produced should run little risk of being contaminated either by dirt or disease.

(2) The animals should enjoy the best of health, and be free from risk of infection of any kind.

(3) The design of the buildings should be such that the labour of feeding and cleaning the cows should be reduced to the minimum, while the comfort of the animals should be the greatest which it is possible to give.

(4) The outlay should be such as will add as little as possible to the cost of production of the milk.

While it is comparatively easy, where the requisite skill is available, to provide new buildings which will meet all the above requirements at even a very moderate cost, it is much more difficult to alter an existing building so that it can be made as suitable for the purpose as a new one. That should not, however, deter owners and occupiers from making alterations on the lines suggested, as under suitable guidance even the most unsatisfactory buildings could often be much improved at moderate cost.

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In designing a cow-house, the principal details which should receive consideration are the following :—

Site, including aspect and arrangement with regard to other buildings.

General construction of the building, including the walls, roof, floor, drainage, and water-supply.

Internal Design, including arrangement of stalls, stall divisions, bindings, feeding troughs, manure and urine channels, passages, etc.

Air-Space, including floor space.

Ventilation, including the various methods by which this is attained ; and *Lighting*.

The Site.—Where there is the opportunity of selection, the site should be moderately high and dry, convenient for the supply of fodder and roots, the preparation and storage of feeding stuffs, the removal of the manure and urine, and should give easy and ample access to the nearest pasture without interference with other stock, and without affording the cattle an opportunity to stray into other parts of the farm buildings, etc. In the designing of a completely new set of farm buildings these can usually be all provided without any great difficulty. It is when a new cow-house is being added to existing buildings, and more especially when no part of these has previously been utilised for dairy purposes, that the greatest difficulties occur. In such circumstances, it is seldom possible to get all the details worked out as completely as can be done where everything is new, but with care and skill there should be no real difficulty in effecting considerable improvement on the average building of the present day.

While shelter from heavy winds is desirable, no cow-house should have any buildings, such as hay or straw sheds, or buildings occupied by other kinds of stock, erected against the side walls. If the building is one such as an open fronted shelter for implements, little objection can be urged against it, but anything which would interfere with the proper ventilation of the cow-house should be placed somewhere else. Land is not so very costly round the

average farm that there is any excuse for crowding buildings together, as is not infrequently the case.

Walls.—The walls may be of any material which is plentiful and cheap in the district, and with suitable precautions equally good buildings may be erected of stone, brick, concrete, wood, or wood and iron. If of stone, or brick, all outside walls should be neatly pointed, and inside ones plastered, or faced with bricks, either enamelled on the one side, or hard pressed. Where plastering is adopted, cement should be used for a height of six feet from the floor. Above that the surface should be smooth, and of such a nature that it can be either washed or lime-washed. If the building is to be of wood, or wood and iron, all uprights and sills should be of creosoted timber. The extra expense will not be great, while the life of the building will at least be doubled.

Roof.—While any kind of roofing material may be adopted, with more or less advantage in particular districts, a wooden roof covered with slates or tiles should be given the preference. No matter what is the material used or what is the design of the building, in every case in this country it should be open to the ridge. Other countries with more severe climates than ours may tolerate lofts and barns above, but here nothing of the kind should be permitted. The extra cost of planing the inside surface of the roof is very trifling, and from various points of view the planing is of considerable advantage.

Floor.—The first point which should be considered in connection with the floor is its level compared with the existing roadway, or completed surface round the building. In the majority of cases but more particularly on level land, or where there is a difficulty in getting sufficient fall for the drains, the floors are laid at too low a level. This is a serious mistake, which there are few opportunities of correcting, and one which is very common in old buildings. The consequence is that the floor and stalls are often damp, and the roadway outside is invariably covered with mud and slush. In not a few instances the roadway outside is difficult to improve, as it cannot be raised, owing to the risk of running the surface water into the building, instead of away from it. These difficulties

should, therefore, be guarded against by fixing the floor at a comparatively high level rather than a low one.

The main flooring materials should be either cement concrete, or blue bricks. Both have some faults, each in a direction different from the other. A perfect material for cow-house floors has yet to be introduced, but with all its faults, good cement concrete, properly laid and finished, is probably the best for general purposes, where clean sharp sand and gravel are available. If suitable sand is not easily obtained, and hard blue bricks can be had at a moderate cost, they may be used in preference to cement concrete. In putting down the floor, either for cement concrete or bricks, the bottom should be laid with stones 6 to 8 inches deep. These should be sufficiently large to fill up the whole depth in one layer, each stone being separately placed in position by hand. A layer of ordinary concrete 3 to 4 inches thick should be placed on the top and well beaten down among the bottoming by hand beaters. Before the concrete has set, it should be covered with one inch or so of two parts of crushed granite and one part of cement. Instead of being floated or smoothed on the surface this should be left rough, as when smooth it is always slippery, unless when well washed. It is generally recommended that the passages and hind part of the stalls should be V-grooved, but this has little effect in preventing slipping where the passages are not kept thoroughly clean, while the wheels of coolers, or other carriages used in the conveyance of food to the stock, invariably break the surface at the grooves. Properly finished concrete is scarcely ever slippery if clean, but may be more or less so if dirty. It is fully as cheap as any other flooring material laid equally substantially, is less absorbent than most, and probably more durable than any other. Where blue brick is used for the passages and stalls cement might with advantage be put in the bottom of the manure channel, as there are no junctions as with bricks to hold urine and manure, and the uniform gradient necessary for this part is more easily maintained with cement than with bricks.

Drainage.—There is general agreement among those who know this subject best that there should be no covered drains

inside the cow-house, or if there are, they should be reduced to the shortest length possible. With buildings having two rows of stalls, particularly those of the largest size, it is not always convenient to have open drains, as occasionally the fall is to the centre, and in that case a covered drain has often to be made from the manure channel to the outside. In such circumstances no one need hesitate in putting in a covered drain, rather than have an open one in an awkward position, where the risks from the open drain may be much greater than from the closed one. In such circumstances no pipe should be put in less than six inches in diameter, and pipes eight or nine inches are to be preferred. The pipes should be given a steep gradient, say, one inch or more for each three feet length of pipe. There should be no bends in the line of piping, which outside the building should end in a small cess-pool. The entrance at the manure gutter should be protected by a grating, and any good pattern of sludge collector.

The drainage outside the cow-house will, in great part, depend on how the urine is to be disposed of. Urine drains are always difficult to keep clear, and in consequence they should be given a good fall and kept as short as possible. If there are any bends, pipes with loose covers should be inserted at each, and if the length is great or fall, little pipes with loose covers should be inserted at frequent intervals.

A good method for utilising the urine is to have a tank close to the dungstead into which all leakage from it should run, and into which the drain from the cow-house should discharge. A urine tank in such a position permits of the contents being distributed over the top of the manure heap, when there is not a suitable piece of land to apply it to. One of the most economical methods of utilising urine is to spread it on permanent hay meadows. If so utilised it may be carted on, but better results will be obtained and less labour will be required if the urine can be diluted with water, and spread over the land by small irrigation channels.

Water Supply.—The best supply is by gravitation from some perennial spring at a higher level, after which come supplies from

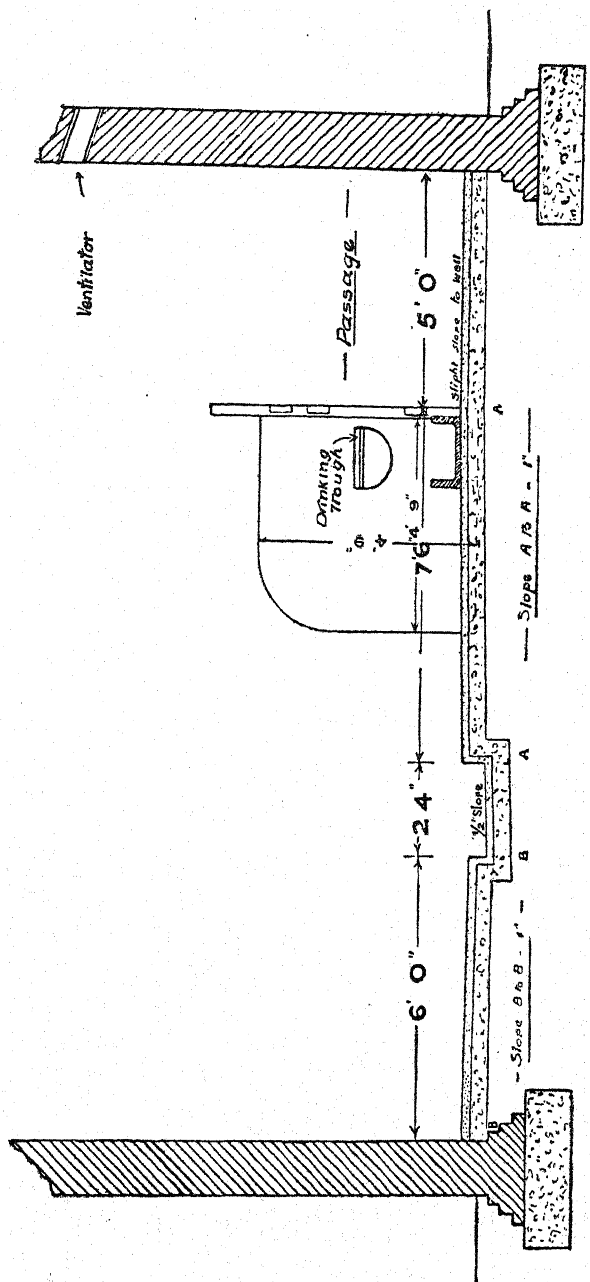


FIG. 1.—SECTION OF COW-HOUSE: ONE ROW OF STALLS AND FEEDING PASSAGE. (SCALE ¼ IN.=TO 1 FT.)

streams, lakes or ponds. In many cases springs and rivers at a lower level can be utilised, and part of their contents conveyed to the farm by a ram or windmill. These sources are only available for a limited area of the country, and in the majority of cases the average farm has to depend on well water. In such circumstances a sufficient supply should be provided in storage tanks at such a height as will permit of it being distributed to the cow-house and milk-cooler.

Internal Designs.—The utility of every building will in great part depend far more on the design adopted than on the materials used in the construction of it. Expensive materials may be used in the construction of a cow-house, yet owing to the imperfection of the design very unsatisfactory results may be obtained. On the other hand, very plain materials, if worked up into a good design, may give very satisfactory results. While excellence in materials should always be aimed at, much more will depend on the design than the materials.

The method of stalling the animals adopted in Fig. 1 is one of the oldest, and at the same time one of the most approved, more particularly where existing farm buildings are being utilised for cow-houses. Many ordinary farm buildings are from 13 to 20 feet wide, and where it is desired to transform them into a cow-house, this can usually be accomplished at a very moderate expense. Where, however, a new building is being erected, it will be more economical to adopt design No. 2, where the same principle is followed as in No. 1, except that two rows of cows are provided for, instead of one.

This arrangement has a great deal to recommend it from various points of view, and although the initial cost is fairly high, the advantages obtained warrant the extra expense. In building a new cow-house, unless for a very small number of cows, the two-row design will in nearly every case be adopted, as the cost per cow is somewhat less than in the single one. The extra cost for a cow-house on this plan is not so great as would appear at first sight. It is desirable to provide a certain cubic or floor space for each animal, and the cost of the extra passage is saved in the

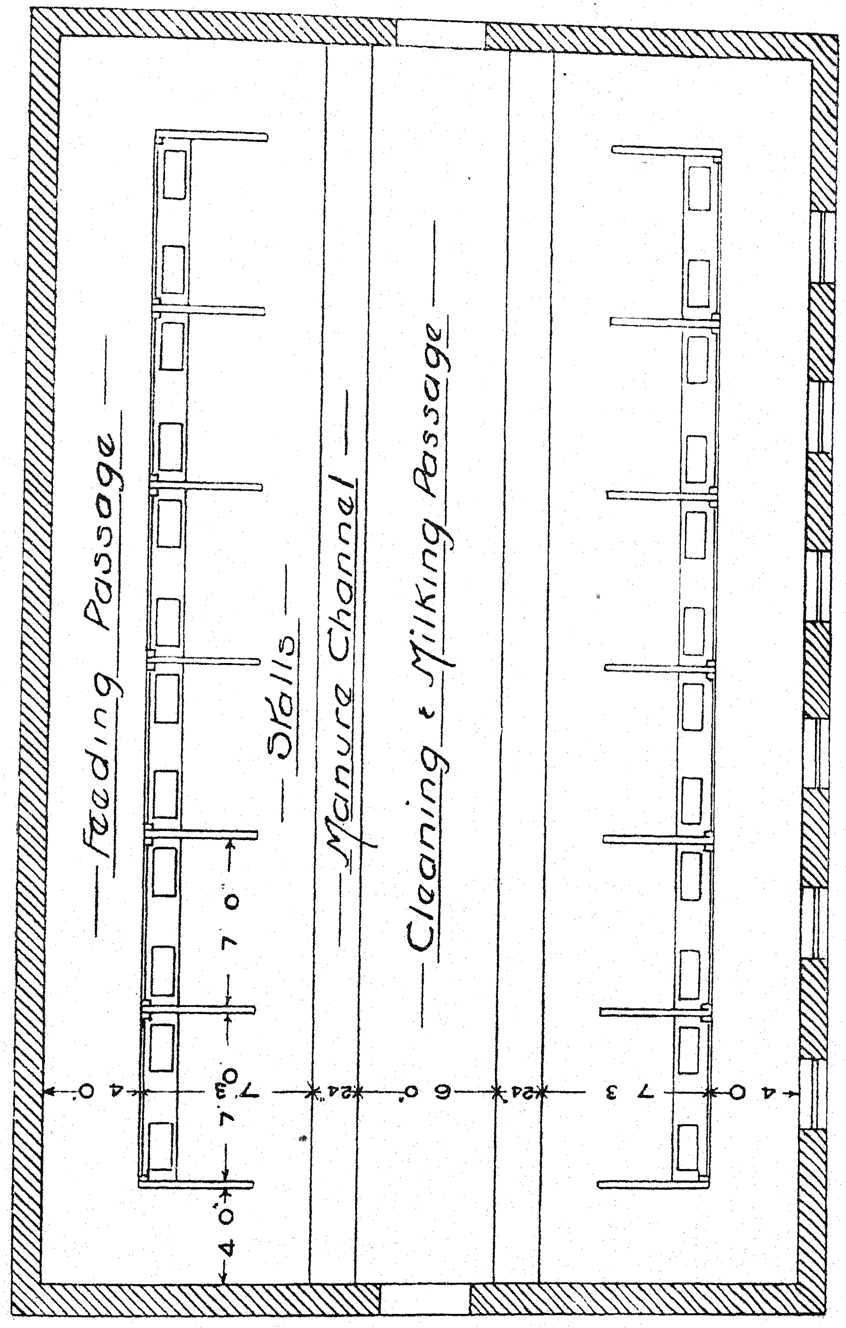
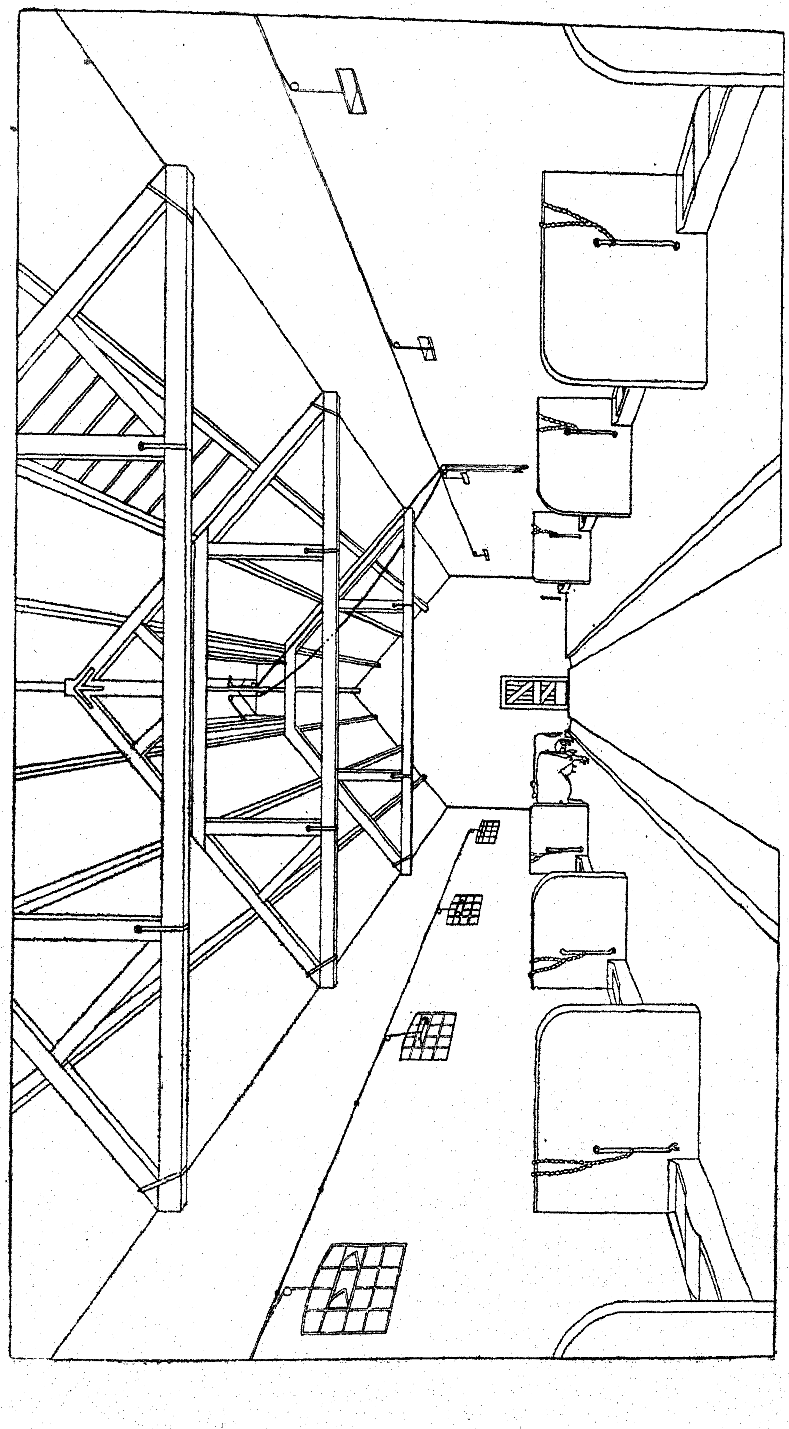


FIG. 2.—GROUND PLAN OF COW-HOUSE : TWO ROWS OF STALLS AND FEEDING PASSAGES. (SCALE $\frac{1}{8}$ IN.=TO 1 FT.)

walls, which do not require to be made the same height as in a building without any passage at the heads of the cattle.

In many of the dairying districts a passage between the heads of the cows and the wall is considered unnecessary and undesirable, because (1) any saving in labour that is effected by feeding the cows from a passage at their heads compared with one from behind is only trifling, and is more than discounted by the extra labour necessary to keep that passage clean; and (2) when animals have been lying for a time they very often pass some excrement as soon as they rise. Where there is a feeding passage at their heads the cows usually rise when feeding begins, and in their anxiety to be fed they generally press toward the passage, and if the fittings permit of it, they often thrust their heads over the division. Any excrement dropped at this time, as is often the case, falls on the floor of the stall, instead of in the manure channel. If this is not cleared away soon after, the cow may lie down on it later on, and soil not only her hindquarters, but also her udder and teats. With a bullock intended to be slaughtered this would be thought little of, as it is not in any way likely to effect the quality of the flesh of the carcase. It is, however, quite the reverse with a cow giving milk, as clean milk can never be obtained from a dirty cow, much less from one with her udder or teats soiled with her own excrement. Milk produced under such conditions is disgusting. Where the division in front of the cows, however, is made high enough to prevent them putting their heads over the top of it, there is no greater liability of the stall being soiled than if the animals were tied up with their heads to the wall.

Cleanliness of the udder and teats or the hands of the milker is a comparative term, and will be variously interpreted by different people. At the International Congress on Dairying at Buda-Pest in 1909 Dr. Paul Schuppli gave the following definition:—"The udder (and particularly the teats) should be so clean that no one would shrink from touching them with lips or tongue." This is one of the best definitions of cleanliness of the udder and teats that has yet been given, and the more it is considered, the greater will be found the necessity for its general application.



INTERIOR OF COW-HOUSE.

FIG. 3.

In addition, milk once polluted can never be made clean, as sieving and pasteurising only cover up the pollution by removing what is objectionable to the sight, but, after all, the pollution remains very much the same as before.

In many parts of the country the most common type of cow-house is that represented in Fig. 3, in which the cows are stalled with their heads to one of the outside walls. In these cases the one central passage serves the purpose of conveying the food to the cows, removing the manure, and taking away the milk. Like plans No. 1 and No. 2, this one may be either single or double, the latter being the cheapest building that can be erected. It does not, however, give the same opportunity for supplying the stock with fresh unpolluted air that designs No. 1 and No. 2 do, as the air at the head of the stalls is always more polluted than in any other part of the building, whereas it is there that pure air is of most advantage.

There is a type of cow-house which is very common in many districts of Britain, but which is objectionable in various respects. In it all the stock are fed from one central passage, while the manure and the milk are removed by the two at the sides. In this case the cows' heads are as far removed from the fresh air inlets as they possibly can be, while the animals breathe into each other's faces from opposite sides of the passage. In a building of this class, where not exceptionally well ventilated, the general health of the stock is likely to be low, and one infected animal in the lot may cause a great amount of damage. It is also defective, in that the passages from which the milking is carried on are usually too narrow to secure milk standing on them from risk of pollution, as where the passages are under 5 ft. or 6 ft. wide, the walls behind the cows are often spattered with dung.

Passages.—The majority of cow-houses usually have the passages much too narrow. A feeding passage cannot be worked in with comfort if the breadth is less than 4 feet, and it will be all the better if made slightly more. Milking passages, no matter whether in single or double buildings, should not be less than 5 feet wide for single cow-houses and 6 to 7 feet for double ones. This width is not necessary, either for feeding or cleaning, but on

most farms, particularly the larger ones, nothing less should be allowed for a milking passage. It is only on the very smallest of farms that each milker carries the milk direct from the cow to the dairy or cooler. The common practice is to have special cans for

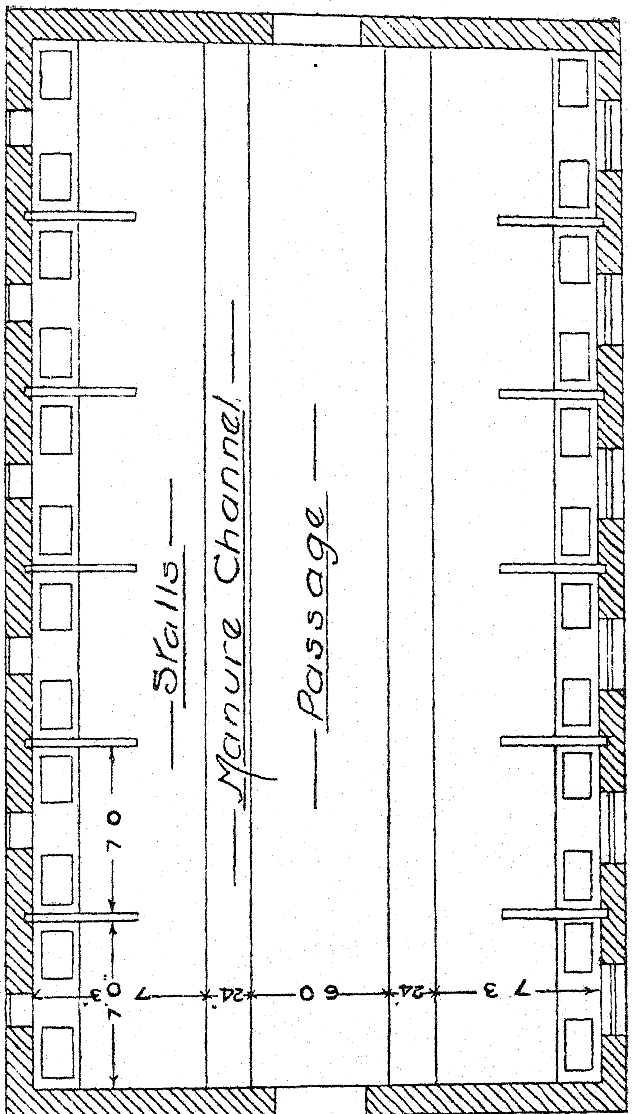


FIG. 3A.—GROUND PLAN OF COW-HOUSE SHOWN IN FIG. 3: TWO ROWS OF STALLS, WITHOUT FEEDING PASSAGE. (SCALE $\frac{1}{8}$ IN.=TO 1 FT.)

carrying the milk, and during the operation of milking these are left in the passage or walk, and as each cow is finished, the milk is emptied into these cans. When full, they are carried to the dairy

or refrigerator and emptied, after which they are returned to their place in the passage. With a double cow-house where the passage is less than 6 feet wide there is always a risk, while they remain there, of a cow near at hand passing either urine or dung, and part of these not only getting splashed on the can, but also into it. The narrower the milking passages are, the greater is the risk of this source of pollution, which, although always present, is more pronounced during the season when pasture is young and succulent. Single cow-houses with 24-inch manure channels and 5-ft. passages behind the cows become spattered with dung even during the winter months, so that it is quite evident that cans of milk standing in the passage run more risk of pollution than most people care to admit.

Stalls.—The stalls of cow-houses only require a very trifling incline from the trough to the manure channel. Each spring when the cows go out to the pasture the stalls should be thoroughly scraped, and all filth removed. This necessitates soaking the stall with water, and, when the dirt has been removed, thoroughly washing it out, and unless the stall is given a fall of from one to two inches, it is difficult to get the floor dried.

Each stall should be proportionate in length to the class of cow that is expected to occupy it For the smallest size of cows, such as Jerseys, Kerrys, and young Ayrshires, the stall measured from the wall or division between the cows and the passage to the manure channel should be from 6 ft. 9 in. to 7 ft long, inclusive of the breadth of the trough. For Ayrshires, a stall of 7 ft. to 7 ft. 3 ins. is quite sufficient, while Shorthorns require from 7 ft. 3 ins. to 7 ft. 6 ins., and exceptionally large cows 3 ins. more. If the stalls are too short for the cows, they will stand in the manure channel, and sooner or later the feet become soft and diseased. If the stalls are too long for the stock, they drop their dung on the floor, and later on when they lie down they are almost sure to soil their hindquarters or udder with it. Where this state of matters exists the extra labour necessary to keep the stalls and cows reasonably clean is very great, and out of all proportion to what is necessary to reduce the stall to the proper length.

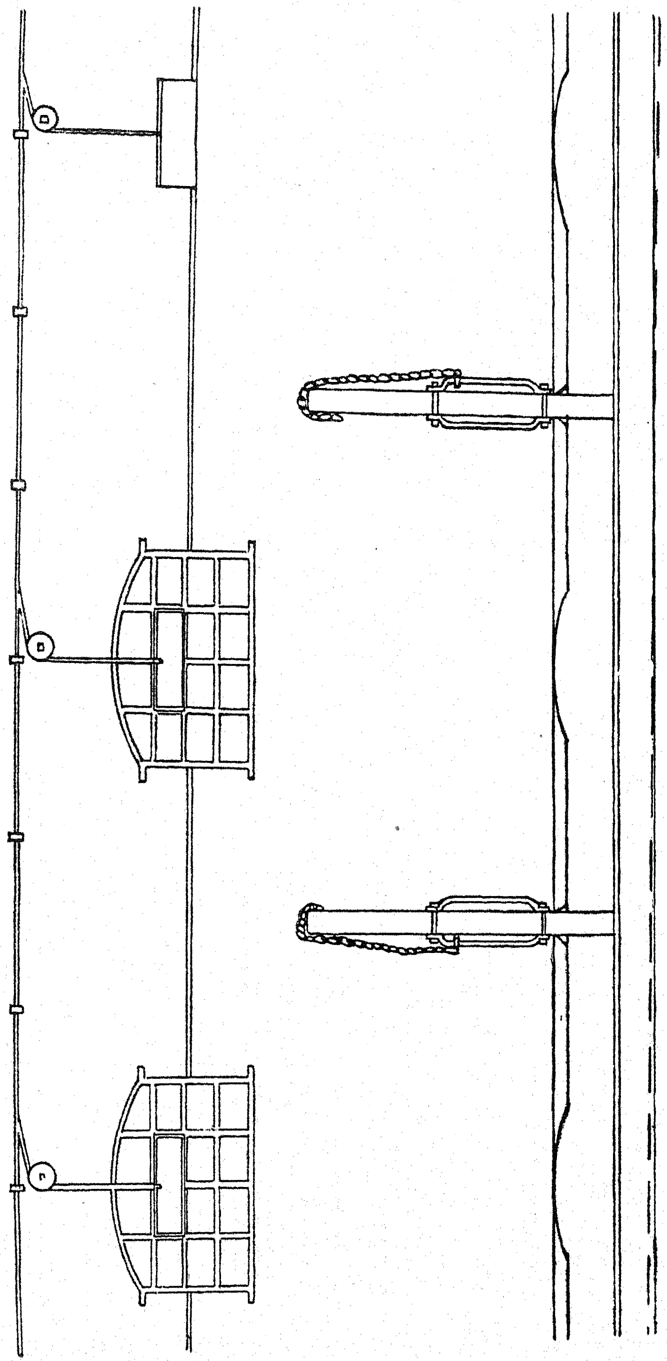


FIG. 3B.—SECTION OF STALLS OF COW-HOUSE SHOWN IN FIG. 3. DOTTED LINE SHOWS FALL IN MANURE CHANNEL. (1 IN. IN 7 FT.).

For the smaller size of cows, each double stall should be from 6 ft. to $6\frac{1}{2}$ ft. in width, and for the larger ones, from $6\frac{1}{2}$ ft. to $7\frac{1}{2}$ ft. wide. If the stalls are too narrow, the cows tread on each other's legs, udder, and teats, and in the latter two cases injury to these almost invariably means loss of a quarter. If the stalls are too wide, the cows turn round in them, and drop urine or excrement in the trough, or on the floor of the stall. While the back part of the stall may be of cement concrete, blue brick or stone, the front part should be of brick or hard asphalt only.

Stall Divisions.—The stall divisions may be of cement, concrete, stone, wood, or iron, or in the event of stanchions being used, they may be done without altogether. Coloured or uncoloured cement 3 ins. thick is, however, one of the strongest, neatest, and most serviceable divisions yet introduced, as it is almost everlasting, and saves painting, periodic washing with water or lime washing being all that is required to keep it clean and bright. The stall divisions should not be less than $4\frac{1}{2}$ ft. long, and 4 ft. to 4 ft. 3 ins. high. With the swinging stanchions used in Canada and the States the cows can be much more quickly tied up than with our method of chains and hooks, while the attendant runs less risk of being hurt by the horns of the animals while so engaged.

Troughs.—Each cow should have a separate feeding trough of thoroughly glazed fireclay, as separate troughs for each animal are much to be preferred to continuous ones. It is a mistake to put in very large troughs, those 20 by 16 by 8 ins. being quite large enough for most purposes. Each double stall should have the space between the two troughs filled up with brick. This keeps each trough sufficiently far away from the neighbouring animal that it cannot steal any food. All the corners along the back and ends of the troughs should be filled up with cement to as long a slope as possible, so as to prevent unconsumed food, bits of straw, and filth of any kind from lodging there, and, when putrefaction begins, setting up bad smells.

Where it is desired to provide facilities for supplying the stock with water when in the house, one of the best of many methods is to have small circular troughs 9 ins. or so in diameter, set in a

recess cut out of the stall division close to the wall or division, and 1 ft. or so above the trough. These troughs should have a lid which is hinged at the back and projects over the edge ½ in. or so, and it should be so arranged that it cannot be lifted up to a perpendicular position. All stock seem to learn to lift the lid with their nose in a few days, and as soon as they have satisfied their thirst, the lid falls and keeps out dust, straw, etc. The level of the water in the troughs may be regulated either by a ball cock, or, if water be plentiful, it may pass off by an overflow at any or all of the troughs. If there is a feeding passage, the overflow may pass away by an open shallow gutter in the floor along the side nearest the troughs.

Manure Channel.—Probably no part of the average cow-house is constructed in so faulty a manner as the manure channel. In no case should it be less than 24 ins. wide, and for large-sized cows it may with advantage be increased to 27 or 28 ins. It should not be less, and need not be greater than 6 ins. deep at the cow's heels, and at the side next the passage 4 ins. will be quite enough. A fall lengthwise in the floor of the channel of ½ in. for each cow is quite sufficient. These in themselves are trifling details, but they are items of immense importance in connection with the cleanliness of the animals, and indirectly with the purity of the milk. The reason for making the manure channel as suggested above is that when the cattle have been in the house for a few hours, the manure which they make is so great that if the channel is any narrower than suggested, it becomes blocked with manure from side to side. In the interval more or less urine is constantly being passed by all the animals, and instead of getting an outlet to the cistern, it remains dammed for the time being between each heap of manure. Under these conditions every time a cow lies down there is a liability of her tail dropping into the pool of urine, which later on she switches over her own body and that of her neighbours. This mixture of urine and thin dung is soon dried by the heat of the bodies of the animals, and during the act of milking part of it becomes detached in the form of dust, and drops into the milk. Cows so stalled can only be kept reasonably clean by

the expenditure of an excessive amount of labour on the part of the attendant, and no matter what amount of care is exercised during the process of milking, the milk itself is sure to suffer.

Before a cow-house can be considered efficient in regard to the cleanliness of the animals, or the purity of the milk, it must be provided with a manure channel having a minimum width of 24 ins., and constructed as suggested. People who have not had experience of a wide manure channel fancy that the cows will have difficulty in stepping across it. Such is not the case, as they seldom make any attempt to step across it. They simply seem to ignore it, as owing to its shallowness they step into it, as if it were not there. Even although every known precaution is taken, extraneous matter will at times enter the milk, but if the manure channel is badly designed, or if the work is indifferently executed, it will be found almost impossible to produce milk even approximately pure.

Floor Space.—While some of the details in connection with the construction of cow-houses have in the past received more consideration than their importance warranted, the question of floor space is undoubtedly one to which somewhat more attention might reasonably have been devoted. It is closely associated with the feeding and milking of the cows ; with the removal of the manure ; and more especially with the cleanliness of the milk. The area required by a cow for her comfort is very much regulated by her size, but all require about a similar number of square feet for proper attention. With passages of the width suggested for the different designs of cow-houses, a floor space of from 40 to 50 square feet will be provided per cow, and for the large class of animals it may with advantage go higher for some of the principal designs. These areas may by some be considered excessive, but it should be remembered that every increase in the floor space also adds to the cubic space, and both materially assist in keeping the air in the building in a reasonable state of purity.

Cubic Space.—By sanitary officers cubic space has hitherto been the standard by which they gauged the efficiency or non-efficiency of a cow-house. Provided that this detail corresponded with

their ideal, little attention was devoted to the other matters already referred to, which have a greater influence on the purity of the milk or health of the stock than does cubic space. It is a very necessary detail of a healthy cow-house, but it has hitherto been given an importance far greater than it deserved. This has been brought about under the mistaken idea that in a building with a large cubic space the air remained approximately pure much longer than where the cubic space was smaller. Where buildings such as churches, halls, and theatres, etc., are occupied for a limited time compared with the interval during which they are empty, the inference is reasonably sound, but when applied to the case of a cow-house in which the animals are constantly stalled for half the year, it breaks down entirely. In the one case the building is flushed with fresh air in the intervals between its occupation, while in the other it is seldom that such an opportunity occurs. The consequence is, that the air of a cow-house, no matter how large its cubic space, reaches a high degree of impurity in an hour or two after it becomes occupied, unless provision is made for removing the polluted air, and replacing it by that which is pure.

This was strikingly brought out in the experiments of the Highland and Agricultural Society during the winter of 1908 and 1909, in which the air of several cow-houses of medium and large cubic space, but with limited provision for change of air, was compared with others similarly placed, where it was liberal. In those which were freely ventilated, the cubic space per cow varied from 520 to 1,268 cubic ft. In the smaller building, where fully ventilated, the average carbon dioxide in the air, on an average of fortnightly tests by chemical analysis, was 10·6 – the minimum being 6·5 and maximum 15·9—per 10,000, the average temperature being slightly under 49° F. In almost similar buildings, with the ventilation restricted, so as to keep the temperature about 60° F., the carbon dioxide in the air of samples taken at the same time as the other was 29·05 per 10,000, and in some instances was as high as 60, 70, and even 88 per 10,000 volumes. On the average of three tests at one of the farms, the air of the freely ventilated building, with a cubic capacity of 1,130 cubic ft. per

cow, contained 9·4 per 10,000, while an adjoining building, with 705 cubic ft. per cow, but with little ventilation, contained 29·03 per 10,000. On two of these farms, at about the same elevation, in the same district, and with much the same exposure, the carbon dioxide in the air of the smaller of the freely ventilated buildings was 10·6, while the very large one was 9·4 per 10,000, a difference of only 1·2 of carbon dioxide per 10,000, although the one building is fully double the other in capacity per cow. In the buildings with restricted ventilation, the amount of carbon dioxide was identical in both cases, yet the one building had 480 cubic ft. per cow, while the other had 705 cubic ft. In both cases the samples were taken between two and three hours after the buildings were closed for the night.

In another case, with buildings at a high altitude and exposed situation, but having a large cubic capacity, the dangers and difficulties of attempting to maintain a high temperature in the cow-house are very evident. The ventilated building with a cubic capacity of 1,268 ft. per cow, and an average temperature of 49° F., had on an average of four tests 19·7 of carbon dioxide per 10,000 volumes of air. In the other half of the same building, where the cubic space was 918 cubic ft. per cow, and average temperature 57·5° F., the carbon dioxide in the air on an average of four tests was 60 per 10,000 volumes of air. At the other farms where this experiment was carried out almost identical results were obtained. The average for twenty-one tests made on five farms in mid-winter gives 12·8 volumes of carbon dioxide per 10,000 of air for the buildings more or less freely ventilated, and having an average temperature of 49·8° F., while a similar number of trials on the same evenings in similar adjoining buildings, but with restricted ventilation and an average winter temperature of 59·4° F., the carbon dioxide present was 34·7 volumes per 10,000 of air. The results of this experiment emphatically show that there is no gain in purity of the air, corresponding with the cost, in buildings of very large cubic capacity per cow compared with those of more moderate size. They also prove that if any cow-house, no matter what its cubic space per cow, is kept at a temperature of 60° F. or

more, its air will contain about three times as much carbon dioxide than if the building had been freely ventilated and kept at under 50° F. While the production of milk may be as great in the one case as in the other, the health of the animals in the freely ventilated building will remain good, while the constitution of the others will gradually become enfeebled.

If the other details in connection with the construction of the building are attended to, it will be found that fairly good results may be obtained if 420 to 450 cubic ft. are allowed for the smaller breeds of cows, such as Jerseys and Kerrys, and young Ayrshires. Breeds of, say, the size of the Ayrshire should be allowed a minimum of 500 cubic ft., and the larger breeds, such as Shorthorns, say, 600 cubic ft. While there will be some advantage in increasing these minima by 20 to 30 per cent., little return will be obtained for the money expended in making them any larger.

Ventilation.—Closely associated with cubic space, but in reality quite a separate subject, is that of ventilation. While a certain floor and cubic space must be provided before the cows can be conveniently and economically attended to, the health of the animals and purity of the milk will in great part depend on the means provided for ventilating the building. Even the thoroughness of the ventilation is much more a matter of providing in the walls ample openings of any kind as inlets for the air, and the same in the roof for its exit, rather than any special system of ventilation. No class of building is so easily ventilated as that which is open to the ridge, and in none may the system which is adopted be so simple and inexpensive. The great requisite is to provide for each animal plenty of inlet area, which should not be less than 40 sq. ins. per cow, irrespective of doors or windows, which should be reserved for exceptional weather, and if the situation is at all sheltered, more should be provided. It does not follow that all available ventilation should be always utilised, but sufficient openings should exist to keep the air fresh—say, 8 to 12 of carbon dioxide per 10,000 volumes when the stock are in, and the air is calm. These openings should be provided with some arrangement by which the inlet of air can be easily regulated to suit the conditions of weather. For instance,

if the wind is strong the volume of air which will pass through any opening will be many times greater than when it is calm, and it is to provide for such occasions that some system of regulation is necessary. The old system of putting straw in the openings in stormy weather cannot be recommended, as when a change of weather occurs the straw is almost invariably in when it should be out, and out when it might be in. The outlet ventilating openings should not be less in area than the inlets, and may with advantage be 100 per cent. greater. Like the inlets, the outlets should be provided with some system of partially closing them when it is desired to do so.

The simplest and one of the most serviceable of inlet openings is a flat one 24 ins. by 4 ins., or 18 ins. by 6 ins., in the wall opposite each double stall. This opening should be between 5 and 6 ft. from the floor if the animals are stalled with their heads to the wall, but if a passage intervenes, it may be somewhat lower, as in this case the current of cold air becomes modified and diffused in its course across the passage, and before it reaches the cows. If a board 9 to 12 ins. broad and 24 ins. long is placed flat along the bottom of this opening, and the edge next the outside of the wall is hinged in any convenient manner, an arrangement can be easily fitted up by which each or all of these boards can be raised, so as to reduce wholly or partially the incoming current of air. The valve may not only be used for reducing the volume of air entering the building, but also for diverting the current in an upward direction, so that it may pass over the bodies of the cows. There are numerous devices for attaining the same end, all of which serve the purpose fairly well.

The simplest system of roof ventilator is a box extending over two or three of the couples, and rising 18 or 24 ins. above the ridge, and having louvre boards on the sides. The main point in these is to have them large enough and in sufficient number. Another method is to have the boarding of the roof, for a foot or so on each side of the ridge, hinged on the under edge, so that it opens up and leaves an outlet 12 ins. or so wide the whole length of the building. Arrangements have to be made for raising and lowering the flaps from the floor.

Light.—Everybody admits the advantages, so far as health is concerned, of an out-door life, but just how much is due to fresh air and how much to the influence of sunlight it is very difficult to say. Sunlight is, however, known to be one of the most powerful, as it is one of the cheapest, germicides we possess; it therefore should be admitted freely into all buildings occupied by stock. It is a matter of indifference whether it comes from the walls or roof, provided it is ample and does not fall directly on the eyes of the animals. The minimum allowance should not be less than 2 or 3 sq. ft. per cow, and it will be an advantage to have even more than that. Of all the details connected with cow-houses, few of them have received so little consideration as that of lighting. This omission has been in part due to the erroneous belief that stock fatten quicker in the dark than in the light; but, in any case, nothing will contribute so much to cleanliness in the cow-house as plenty of light. It costs little, and its value there is great, if it were for nothing else but to afford an opportunity of seeing the dirt.

Manure and Food Conveyors.—No cow-house can be considered complete which is not provided with an overhead railway for the purpose of removing the manure, and bringing in food and litter. In Canada and the United States these are found everywhere, their cost is trifling, and the labour they save is great. The manure bucket is self-emptying, holds between three and four barrow loads, and is more easily pushed than an ordinary barrow, and if the rail can be laid with a slight fall to the dungstead, the load may run out and empty itself. Separate buckets are used for the carriage of the manure and the food.

NOTES.

The assistance of the Court of Wards in Agricultural Improvement.—It is well to define at the outset the limits of the activity of the Court of Wards.

(1) Apart from statutory limitations which exist in some provinces, the Court is morally in the position of a trustee, that is to say, it cannot spend money freely in the way a landholder can; it is justified in making improvements which will either increase the rent-roll, or ensure larger collections in unfavourable seasons, or contribute to the general welfare of the tenants, but it is not justified in spending money on costly experiments.

(2) The tenure of the Court is uncertain, and there is in ordinary circumstances little hope of continuity of management after its term expires. The best chance of carrying out a long-term programme exists where a solvent estate comes under the Court for a minority of 15 to 20 years; but even in that case the minor may die and be succeeded by an adult. Hence elaborate schemes of stock-breeding, afforestation, and the like which require prolonged maintenance before a financial profit accrues are ordinarily unsuitable to the conditions.

(3) A very large proportion of the estates under the Court are so deeply indebted that expenditure in all directions has to be cut down to the lowest limits.

It follows from these limitations that the capital expenditure on improvements is most likely to be justified when it is incurred once for all on works of definite agricultural utility such as irrigation or drainage projects. In the larger part of the United Provinces the need for more masonry-wells is more pressing than anything else, and I have usually advised that

estates with moderate resources should practically confine their capital outlay to the provision of wells so long as these are required.

There are, however, ways in which the management of the Court can aid in the improvement of agriculture without heavy initial outlay. Among those that are suited to the province may be instanced.

(1) *Introduction of new staples and renovation of seed-stocks.*—In this case the capital invested in seed can ordinarily be recovered at harvest, and the amount required in any year is not large as the introduction must be gradual. Sugar-cane, ground-nuts, and better varieties of wheat and other crops have thus been introduced in particular estates.

(2) *Maintenance of implement depôts.*—Where cultivators can buy or hire such things as improved ploughs, sugar-cane mills, irrigation-pumps, well-boring tools and the like, these depôts should be self-supporting almost from the start and can be opened on quite a small scale: the most essential feature is a mechanic able to keep the implements in order and execute necessary repairs. It has also been found advantageous to give away a few implements or lend them free of cost to tenants who have earned a reward in cases where it is desired to popularise a new implement.

(3) *Provision of facilities for the demonstrations of the Agricultural Department.*—These cost little on the lines on which demonstrations are worked here, since the department asks for little beyond the loan of a field here and there and the use of bullocks for tilling it. Past experience of demonstrations conducted by the subordinates of the Court has been highly unsatisfactory: hence the desirability of the conduct of the demonstrations being in the hands of the Agricultural Department in cases where the Manager himself is for any reason unable to supervise them effectively.

(4) *Provision of facilities for experiments at Government cost.*—The Court can render much assistance by providing land and other facilities for experiments which it is desired to carry out in a particular locality.

(5) *Maintenance of communication between the tenants and the Agricultural Department.*—This is not a matter of expenditure: on the one side, there is the distribution of the department's leaflets or popular bulletins so that they may come into the right hands: on the other, there is the prompt supply of information to the department in cases (*e.g.*, outbreak of insect-pests) where its help is required, and assistance in any operations which it proposes to conduct.

To secure success in operations of the nature indicated above, close co-operation is required between the management and the officers of the Agricultural Department (except where as in Madras the Court employs an agricultural expert of its own). Formerly this co-operation was secured to some extent by periodical conferences of the Managers under the Chairmanship of the Director of Agriculture; of late years the practice has been that when an important estate comes under the Court, the Director or Deputy Director confers with the Collector and the Manager, and a scheme of improvements is agreed upon. Further the portions of the Managers' annual reports dealing with agricultural improvements are reviewed by the Director in a note to the Court. The main point is to establish harmonious personal relations between the Managers and the Officers of the Agricultural Department.—(W. H. MORELAND).

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SOME MANURIAL EARTHS OF MYSORE.—In Vol. IV, Part I of this Journal, Mr. Harrison, Agricultural Chemist to the Government of Madras, gave an interesting account of "Patti Mannu", which is being used by the *ryots* of the Krishna Delta as manure for paddy-fields. In certain parts of the Bangalore district in the Mysore State, a similar practice exists of using as manure of earth dug out from what are probably the sites of old and deserted villages.

Some samples were taken for analysis from the villages, Chikkabanavara, Kakolu, Kadanur, Rajagatta and Andarlahalli in the Bangalore district where the earth was dug from fields close to existing villages. In almost all of them fairly large

excavations have been made, some of them over two hundred feet square and six feet deep. In the village of Tubkunte it is reported that the excavations are some acres in extent. But all the larger ones have now been abandoned by the order of the Revenue authorities as these areas are unfit for cultivation. In other places small pits are dug in the fields just before the cultivation season commences, and the earth is either sold or used by the owner himself. The price of the earth varies from four annas to eight annas a cartload.

The earth is ash-coloured, as its Kanarese name "Boodhi Mannu" indicates, and is very light and porous with a free admixture of sand. The pits always contain pieces of broken pottery and also occasionally pieces of bones.

In the above-mentioned villages the earth is used as manure for *ragi*, and in one of them for sugar-cane also. It is reported that in years of good rainfall this manure gives good results, while in years of poor rainfall it is more a disadvantage than otherwise—a fact which finds an explanation in the sandy and porous character of the material.

Nine samples were analysed to determine the amount of nitrogen, phosphoric acid, lime and potash. The analyses are given below :—

Number of samples.	Locality.	Nitrogen.	Phosphoric Acid.	Lime.	Potash.
554	Andarlahalli	·035	·54	2·50	·35
555	Ditto	·040	·62	2·75	·55
561	Chikkabanavara	·120	1·10	4·00	·42
560	Ditto	·052	·56	·82	·31
562	Kakolu	·230	1·60	2·73	1·02
563	Ditto	·084	1·16	3·25	1·19
566	Kodagahalli	·077	·58	2·76	·45
573	Kadanur	·057	1·60	3·60	·99
574	Rajagatta	·057	1·20	2·82	·52

The samples are all strikingly rich in both lime and phosphoric acid and some of them in the other constituents as well. Sample No 562, which shows the highest percentage of nitrogen, is the only one found to contain nitrates also. Sample No. 560 is not really a sample of "Boodhi Mannu", but a sample of

surface soil of a field a few feet below which the characteristic ash-coloured earth was dug, and out of which sample No. 561 was taken. The surface soil of the adjoining fields was somewhat similar in appearance, and this sample was analysed to see if the soil of these fields was also rich. It certainly does contain a good percentage of lime and phosphoric acid. Sample No. 574 is a sample of "Boodhi Mannu" taken from the village of Rajagatta which, according to a tradition, produces the best *ragi* in the whole province. The earth is largely used to manure *ragi* fields in the village; the soil of the fields of this village resembles manurial earth in appearance, and it is reported that almost every field contains this earth, and has been dug for the sake of the manurial earth at one time or other.—(A. K. YEGNA NARAYAN AIYAR).

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REPORT ON "KAHNO" WHEAT FROM SIND.—This wheat is grown at present to a limited extent in Sind chiefly for domestic consumption. It was found on the Government Farm at Mirpurkhas to be an excellent yielder, hardy grower and to have good rust and "kalar" or alkali resisting properties. On enquiry, however, from various exporting firms in Karachi, it was found they would not buy as they stated its only use was as *macaroni* wheat. The Imperial Institute, London, reported as follows :—

Chemical Examination.—"The wheat was examined chemically to determine the proportion of gluten present with the following results :—

	Sample as received.	Gluten in dry Wheat
Gluten per cent. ...	... 11·70	13·46
Moisture per cent. ...	... 13·10	...

"The gluten was of good quality, fairly elastic, and not too dark in colour.

"The amount of gluten in American *macaroni* wheats usually varies from 12·5 to 17·9 per cent. in the dry wheat and occasionally rises to as much as 20 per cent.

Commercial Valuation.—"Samples of the wheat were forwarded to firms for *macaroni* manufacturers in France, Italy

and Sicily for examination. The Sicilian firm stated that this Indian wheat may be considered suitable for making *macaroni*, but they pointed out that when large quantities of wheat of this quality were imported into Sicily it was found to answer the purpose better if mixed with hard *taganrog* wheats, in the proportions of one-third of the latter.

"A firm in Naples reported that this wheat was perfectly suitable for making *macaroni* and stated that they would like to receive offers of consignments. Information is given below as to the average price of *macaroni* wheat in Naples.

"A London firm doing a large trade with Italy in wheat for *macaroni* expressed the opinion that this sample of Indian wheat had been especially hand-picked for exhibition purposes, and they were of opinion that nothing like it could be delivered for consumption. This firm also stated that if the enquiry was connected with a proposal to export the wheat they would be glad to receive offers.

"A French manufacturer of *macaroni* who was consulted, drew attention to the existence of great prejudice against Indian wheats on the part of *macaroni* manufacturers in France and Italy on account of the prevalence of weevils in the grain. He stated that as a rule manufacturers in buying wheat ask for a guarantee that Indian grain is absent. Recently, however, offers of Indian hard wheat had been received at Marseilles, owing probably to the present storage of hard wheats.

"With reference to the prices of *macaroni* wheat in Europe it is stated that the only hard wheat at present imported into Naples for the manufacture of *macaroni* in Russian hard wheat, which is sold at the average price of 22·75 lire per 100 kilos (equivalent to 9*s.* 3*d.* per cwt.) c.i.f. in bulk, cash against documents, one per cent. discount. Of Indian hard wheat, only small lots have been sold of Hard Red 70 per cent. at $22\frac{3}{8}$ lire per 100 kilos (9*s.* $1\frac{1}{2}$*d.* per cwt.) c.i.f. in bags, gross for net cash against documents, one per cent. discount. There is also a commission of one per cent. from seller to agent to which the above prices are

subject. The great difficulty in the importation of Indian wheat is the time of shipment.

"Shipments should be made before the 15th May by direct steamers of the Navigazione Generale Italiana, as otherwise the wheat would come in when the new crop was ready."—(G. S. HENDERSON).

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AKUND COTTON.—In Part III of the 'Indian Industrial Guide' published in 1907 by Babu D. R. Ghose, B.A., of the Provincial Civil Service of Eastern Bengal and Assam, an account is given of jungle products likely to prove profitable articles of trade to men of little or no capital. Amongst these is mentioned *Akund* Cotton and the reference has led to a moderate degree of enquiry.

In this note *Akund* cotton is said not only to be in good demand for export but large quantities are used in Europe and America for the purpose of making lint cloth and a kind of bandage cloth for rheumatism and gout patients. The paragraph concludes with the remark that there may be other uses for this cotton but these are not known here. In the succeeding paragraph, however, we are furnished with definite information to the effect that this may be used for spinning and for weaving other kinds of cloth, and that people with a knowledge of the cotton trade predict a good future for it.

The same authority proceeds to say that eighty per cent. of *Akund* cotton is supplied from Agra and its surrounding districts. In Bengal it is totally neglected. The *Akund* is one of several kinds of tree cotton found in India and at Agra and the surrounding districts it is in regular cultivation. An incomplete botanical and agricultural account follows. We are assured that the total cost of production may not be more than Rs. 4 to Rs. 5 per bigha or for $2\frac{1}{2}$ maunds of clean cotton, which may easily fetch Rs. 30 at the lowest. Sometimes it sells as high as Rs. 20 per maund. The plants do not suffer either from drought or from excessive rain. Besides the profit from the sale of cotton, there is a very handsome profit from the sale of the leaves and

the stalks yield a soft and very light fibre which in itself would form a paying industry. Thus far we have followed the Industrial Guide.

Mr. Leake, Economic Botanist to the United Provinces, after examining specimens of *Akund* cotton from the Agra District, kindly informed me that the plant is the common *Madar* (*Calotropis gigantea*) and not a species of Gossypium. The Dictionary of Economic Products gives the name of *Akund* (for Calotropis) as being current in the Hindi, Bengali, Marathi and Gujarati languages. As regards its properties and uses, the *Sap* is said to yield a form of Gutta Percha. (This error, however, has been corrected by Mr. D. Hooper, who says the substance is only a pseudo gutta). A *manna* is said to exude from the plant. The best fibres and floss from the seeds are well-known fibres. The root bark and sap are medicinal. A liquor is reported to be prepared from the juice. The wood is used for gunpowder, charcoal and various parts of the plant are employed for sacred, domestic and agricultural purposes. Full details on all these points can be obtained by a perusal of the valuable article by Sir G. Watt. The truth in a kernel concerning the floss is simply this: the silk cotton from the seeds is known commercially as "Madar Floss," it is employed to some extent for stuffing pillows; Balfour says it is used in Madras for making soft, cotton-like thread and Mr. Moncton found that when a mixture of one-fifth cotton was made, a good weaving cloth, capable of being washed and dyed was produced. Finally, from all accounts, it appears that the floss can only be spun when in combination with cotton, but the variation in its quality and the intermittency of the supply offer practical difficulties in the way of its use. The facility with which *Madar* can be grown even in the most arid and barren situations is sufficient reason for a plea that the plant and its properties should be the subject of earnest investigation, but we cannot believe that it will ever become either a serious competitor to cotton or even a vehicle for its adulteration.—(G. A. Gammie).

Sugar in British East Indies.—An interesting series of articles on "Sugar in the British East Indies," by Mr. Peter Abel, has recently come to a conclusion in the *Louisiana Planter*. That Journal rightly says that its readers will find in the several issues that have contained Mr. Abel's articles, a supply of East Indian sugar-cane data nowhere else available.

It is a misfortune, however, to Mr. Abel's readers that his observations were made on a hurried tour through India in the cold weather, and that, as he laments in his article, his opportunities of access to reliable references were so few and far between.

As a result probably of this difficulty of access to official literature we find that the only tables given by him are from one or two official publications of the Bombay Presidency, and in one article cut bodily from a bulletin by Khan Bahadur Sayed Mohomed Hadi, of the United Provinces.

We find, for instance, that he states without reference to differences of practice in different parts of India, that the manurial application is 40 tons of farm-yard manure per acre, followed by 15 to 20 tons of poudrette or 4 tons of safflower cake, which is, to say the least of it, not usual on this side of India.

Owing, again, to the shortness of his stay he does not appear to have been impressed sufficiently by the difference in climatic conditions, and he has thrown the estimated costs and produce of different parts into violent contrast without laying sufficient stress upon the possibility of varying conditions. He appears to be very dissatisfied with the different estimates of cost and profit and throws those of the Punjab into violent contrast with those of Bombay.

Mr. Abel and most of his readers know that Lahore and Bombay are in different latitudes, but mere latitude cannot produce the enormous differences of climate between the two. His lack of access to official literature appears also to have again rather led him astray. In one case, that of Bengal, he states that it is possible that an error was here made from the lack of consideration of cost of labour.

He quotes (*Louisiana Planter*, Vol. XLIII, No. 3) Mr. Banerjee's remark: "It must be remembered that much of the labour expended both in cultivation and the manufacture of *gur* is supplied by the cultivator's own family, and the net profit is, really, therefore, greater than these figures indicate." He appears to read this as meaning that the cost of labour has not been included, for he makes the remark that "this would indicate that Mr. Banerjee has not included the cost at its selling price of the labour employed in growing the cane."

It is difficult to understand in the first place how from Mr. Banerjee's words this inference can be drawn, and in the second the figures published by Mr. Banerjee are the total of a carefully compiled table (Departmental Report on Sugar-cane), showing every item of expenditure from start to finish.

This appears to be the only instance in which Mr. Abel has attempted to account for the discrepancies between figures in different Provinces.

As regards the necessity for irrigation, and his impression that in some cases excessive water is used, it is perhaps certain that the cultivator will take as much water as he can, knowing, as he does, the awful yearly Indian drought which he has to face.

It is a pity, however, that Mr. Abel has not given specific examples of water-logging, instead of merely quoting official figures taken by him from Poona, from which he deduces the fact that water was given totalling 77·5 inches, to which he adds the 16 inches yearly rainfall, making a total of 93·5 inches.

He states that this is "a heavy rainfall, much too heavy for a clay soil even if fairly well-drained."

As these figures from Poona together with some from Baramati in the same Province are the only ones he quotes, we are led to believe that these are the most striking instances of the misuse of water. It is possible that he may have seen water-logging, but, if so, it would add much to the value of his useful article, if he quoted the instances.

Referring to this excessive use of water he states that "this is not likely to occur where the water has to be raised from wells."

Those who have had to irrigate by means of wells will agree with Mr. Abel.

In Patna district the estimated cost of irrigation by canal is Rs. 10-9-6 and by "mote" (from wells), Rs. 18-0-0 per acre, sufficient argument in itself to uphold the cause of the canal against that of hand irrigation. It is possible that the difference may not be so great in other parts of India, but for Bengal at any rate there is no doubt of the saving effected by the great canal systems.

It is obvious that Mr. Abel had no intention of arguing from a special case, and accounts are given by him of agricultural practice all over India; but the limited amount of time and documents at his disposal do not appear to have forced upon him the main difficulties which the Indian Sugar-cane Industry has to face, which are :—First—the system of land tenure; Second—the lack of irrigation; Third—the intense dryness of the majority of India during the months from January to June or July which, unless one has experienced it, renders almost impossible any attempts to give an idea of the amount of irrigation required in figures of inches of water.

The amount of information furnished by this paper is enormous, and the work done by Mr. Abel in collecting it during the few months in which he was in India was colossal. As is to be expected, however, in such a large number of facts it is difficult to avoid an occasional pitfall and almost impossible to lay sufficient stress upon the one or two points that are in all probability of primary importance.

As an account the article is excellent; it is only in Mr. Abel's criticisms in which he perhaps fails, from an insufficient supply of data.

As he himself says (*Louisiana Planter* 43, No. 2, page 29), in connection with the irrigation problem, "many conditions are involved." How many and various these conditions are, can only

be gathered even in one Province by a lengthy residence on the spot, and in a tour of only four months one can hardly do more than touch their fringe.—(C. SOMERS-TAYLOR).

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POTATOES IN UPPER BURMA.—An enquiry as to the origin of the potatoes exhibited for sale in most of the large bazaars of Upper as well as of Lower Burma will reveal the fact that only a small proportion of the potatoes consumed are the produce of this country. Many are imported from Calcutta or from Europe—the so-called "Calcutta" potato is generally the produce of Italy or some other European country; a fair proportion of marketable produce comes down from the Shan States, and the remainder is produced in Burma proper. In no part of the country is the potato extensively grown as a field crop, but it has reached the stage of an important garden crop, the cultivation of which is in some parts gradually extending to field areas. On the islands and inundated lands of the upper reaches of the Irrawady, for example, the potato crop is a regular one in the hands of many cultivators. This is particularly the case in the Bhamo and Katha districts, where the cultivation was probably started by the Shan inhabitants, who still hold a large share of the land under this crop. The Shan, who is usually a better gardener than the Burman, and bestows more care on his crops, evidently recognised the value of these inundated lands for growing potatoes, and was the first to commence their cultivation. But the Burman is an apt pupil when he finds it is to his advantage, and especially in the Bhamo district, he is rapidly following suit—so much so that were it not for the difficulties and heavy expense of transport the markets of Burma might before long be filled with the "Bhamo" potato instead of the imported article.

Varieties.—In the Bhamo district the following eight varieties are easily recognisable, and some or all of these are cultivated to a small extent along the river at least to the southern borders of the Mandalay district.

The cultivators only distinguish three or four varieties by means of the colour of the skin and the size of the potatoes. In

some cases two or even three varieties were found mixed together under one local name. For the purpose of convenience in classification these varieties are distinguished by numbers and have been divided into (1) white-skinned and (2) red-skinned varieties; and each of these divisions may be again divided into (*a*) round and (*b*) oval or kidney-shaped varieties, and so on.

No. 1. A white-skinned variety of medium size and very regular oval shape, with a rough skin and very shallow eyes closely clustered near the "bud" end of the potato. The flesh is white and of excellent quality.

No. 2. A white-skinned variety of large size and elongated oval shape; the skin is rough (especially in patches), and the eyes are not deep, but not so shallow as in No. 1, and they are often distributed throughout the whole length of the tuber. The flesh is white and the quality very good.

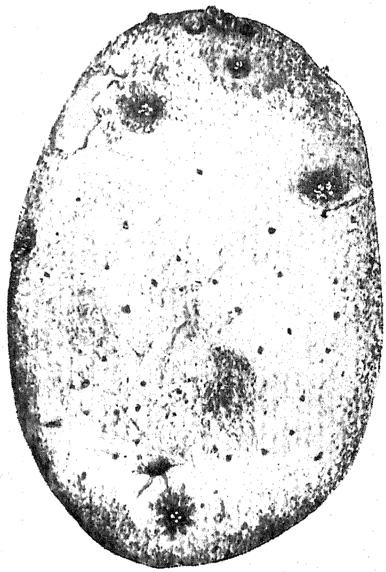
No. 3. A white-skinned variety of large size, elongated oval shape and irregular outline with prominences bearing dense clusters of eyes. The skin is usually very rough in patches and the eyes are shallow but densely clustered on the end and on the lateral prominences of the potato. Flesh white or slightly yellowish in colour and of good quality, though somewhat coarse and not equal to Nos. 1 and 2.

No. 4. A white-skinned variety of large size and round shape, outline not very regular. The skin is smooth and the eyes very deep. The flesh is yellow and not of very good quality, being hard and waxy when boiled.

No. 5. Very small potatoes called by the cultivators "Shan" potatoes, mostly round in shape and rough skinned. The flesh may be white or yellow. These potatoes appear to be a mixture of the "chats" or small potatoes of the preceding white varieties, and are sold at a little over half the price of the larger ones.

No. 6. A red-skinned variety of fairly large size and somewhat irregular oval shape. The skin is smooth and the eyes are not deep. The flesh is white streaked with pink and of very good quality when boiled.

PLATE II.



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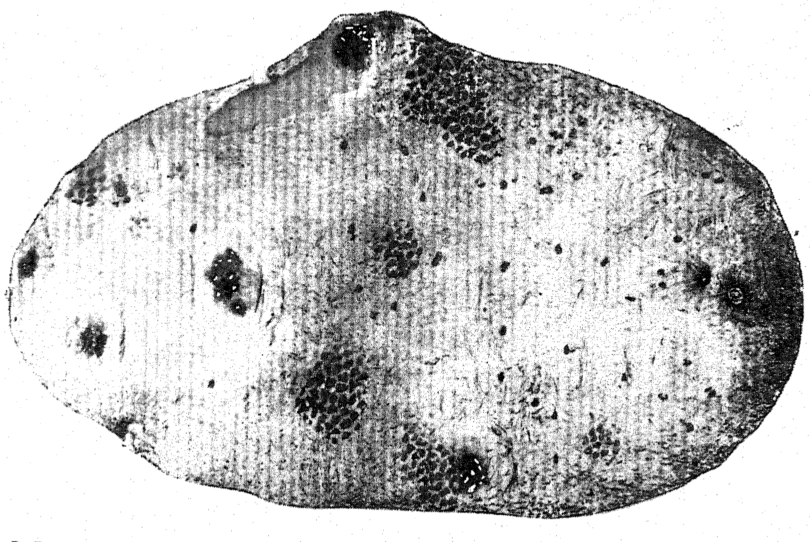
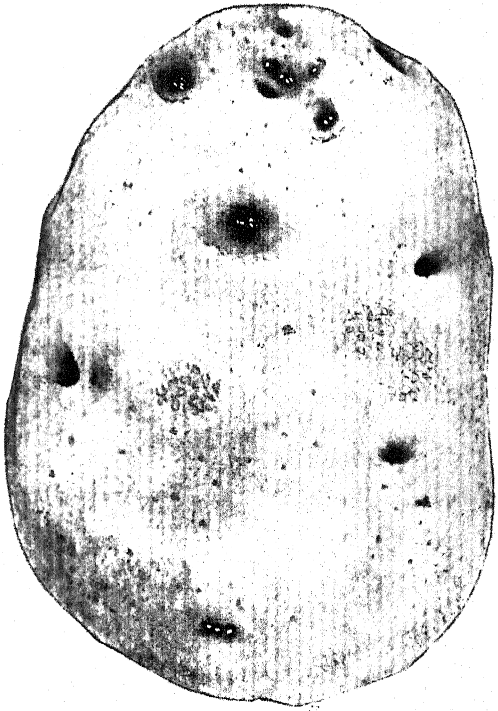


A. J. I.

No. 3.

PLATE III.



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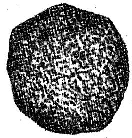

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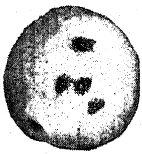

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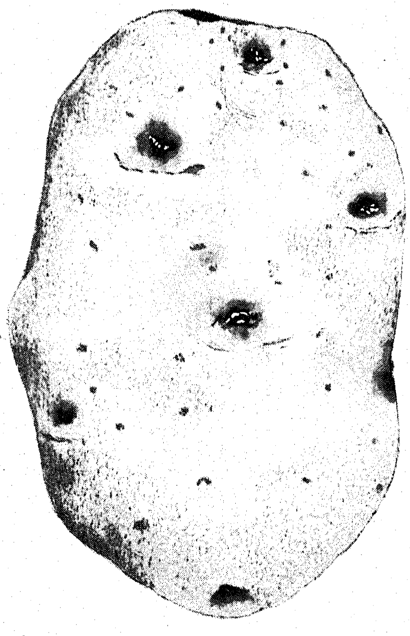

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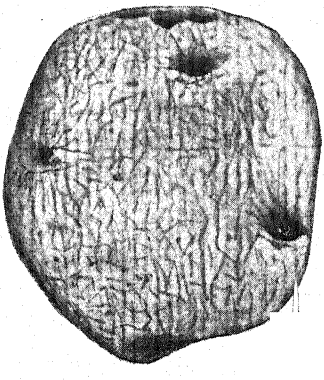
A. J. I.

PLATE IV.

No. 7.



A. J. I.

No. 8.

No. 7. A variety with a red skin, of medium size and oval shape, skin smooth and eyes of moderate depth, the flesh is white, sometimes slightly yellowish, and the quality is good.

No. 8. A round red-skinned variety with very deep eyes. The tubers are of fair size only, and the flesh white to slightly yellowish in colour. When boiled the quality is good.

Cultivation is generally very simple and takes place only in the cold weather—except in some parts of the hills where it is cold enough for the successful cultivation of potatoes during the rains. The chief methods are shortly as described below :—

I. *On Inundated Lands.*—Though the islands and low-lying lands along the banks of the Irrawady River, which are annually inundated during the rainy season, are, generally speaking, well suited for the cultivation of potatoes and other vegetables, there still remain large uncultivated tracts. The soil is either sandy or of a very light loamy nature and very easy to cultivate. In many places where the water does not flow rapidly over the land, but simply rises and falls gradually, deposits of fine silt or mud are often left behind; and apart from these deposits manure is seldom used, except near the villages where a little cowdung or sweepings may be applied before ploughing. As soon as the water leaves the land, usually about the beginning of October, cultivation is commenced. The land is ploughed once with the "htè" and harrowed with the "htun" two or three times until it is cleared of weeds and a fine tilth secured. Sometimes it is only harrowed. The sets are usually planted whole and in rows by being placed in holes made to a depth of 4 or 5 inches at a distance apart of one cubit (*i.e.*, about 15 to 18 inches). The distance apart of the rows is also about 15 inches and the holes are made by hand by the aid of the "paukpya" or "mamootie," the "tuywin" (spade), a stick or any convenient implement. No drills are raised, and after dropping the sets the holes are filled in with earth. Very little choice of sets is made, except that, as a rule, the very small ones are discarded, and cut sets are said to decay rapidly instead of sprouting. As soon as the shoots appear above ground, hoeing is done between the rows

and is repeated two or three times during growth. At each hoeing the loose soil from between the rows is heaped up slightly around the plants. Irrigation is not generally carried out and the crop is ripe in about four months after planting. When the haulms have assumed a yellow colour and before they are completely dead, the potatoes are dug up by hand.

II. *On the higher lands* they are, as a rule, grown in gardens only and often receive a little manure in form of cattle dung, village scrapings, etc. They are planted out at the end of the rainy season and cultivated in a way similar to that described above.

III. *On the hills* they are also cultivated as a garden crop and receive a good supply of cattle manure. Though usually a cold weather crop, in the higher Kachin Hills they were seen growing in the warm weather, having been planted about the beginning of March. They were not planted in rows but irregularly at distances of about 18 inches apart. The transport difficulties from these hills prohibit the growth of potatoes for export to Burman markets.

Rotations.—With garden crops definite rotations are rarely followed, but potatoes are often seen growing mixed with oil-seeds and vegetables—particularly cucumbers of various kinds. On the river lands they may be rotated with a grain crop or with sessamum, but generally they are grown together with vegetables, and as unoccupied land is usually abundant, the cultivator takes only a few crops in succession before leaving his land fallow. During flood time also the lands here are constantly being washed away and new lands formed.

Outturn.—The figures obtained are somewhat confusing and probably not very reliable, but the outturn is nowhere very large—not more than four or five tons per acre in the best places. The yield is often very considerably reduced by the attacks of Potato disease (Phytophthora), which appears to be very common.

Prices.—At Bhamo the prices run from anna one to a little over annas two per viss (3·65 lbs.). The higher price was paid for the best of the large varieties and the lower for the small "Shan"

varieties. In Mandalay the average prices per viss may be taken as follows :—

Best Calcutta potatoes	...	...	...	4 to 4½ annas.
Large Burmese or Shan	...	...	...	4 annas.
Medium do. do.	...	...	...	3 annas.
Small "Shan" potatoes	...	...	...	2 to 2½ annas

At these prices it is quite probable that the increase in area under potato cultivation in Upper Burma will continue, and as the quality of some of the large varieties is quite equal to the best imported potatoes, there is no reason why the supply for our chief markets should not be grown in this country.—(E. Thompstone).

REVIEWS.

PRINCIPLES AND PRACTICAL METHODS OF CURING TOBACCO BY W. W. GARNER, BULL. 143, BUREAU OF PLANT INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE, FEBRUARY, 1909.

DURING recent years the study of the many aspects of the production and curing of tobacco in the United States has engaged the increasing attention of the Bureau of Plant Industry at Washington. At the present time no less than sixteen members of the scientific staff of this section are working on the improvement of tobacco. The results so far obtained are said to have attracted considerable attention on the part of practical men and a good deal of the work appears to be carried on in co-operation with the growers. The present bulletin deals with two main subjects. In the first place, attention is devoted to a popular exposition of the scientific principles underlying the various curing processes, while the second part of the paper consists of an illustrated account of the practical methods of curing as applied to the various types of tobacco grown in the United States, such as cigar, barley, yellow and heavy export tobaccos. This bulletin is perhaps the best summary of a many-sided subject which so far has been written and will no doubt be read with interest by all engaged in the improvement of the tobacco crop in India.—(A. HOWARD).

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SECOND AND THIRD ANNUAL REPORTS OF THE COMMITTEE OF CONTROL OF THE SOUTH AFRICAN CENTRAL LOCUST BUREAU, 1908-1909.

IN a previous issue (Vol. IV, Part 3) we noticed the work of the Locust Bureau as detailed in its first annual report. We

have now the Reports for the whole period 1907 to 1909, prepared by C. Fuller and C. P. Lounsbury. The Bureau has settled down to practically two functions: the first is the collection of all data regarding the occurrence and movements of Locusts in the Cape Colony, Natal, Transvaal, Orange River Colony, Southern Rhodesia, Bechuanaland Protectorate, Basutoland, Swaziland, Mozambique and German South West Africa, with the issue of warnings to all these areas; the second is the gathering together of reports of the action taken in each area by the several Governments concerned, and the communication of these to the others. It is a co-ordinating bureau, with no powers of control, jointly maintained by all the Colonies which benefit.

Two kinds of locusts are concerned, one essentially a desert species which breeds in arid sandy areas and thence flies out in swarms, the other dependent upon moister conditions. The first is normally an inland species, starting from the Kalihari Desert, the other a Coastal species, originating in the moister areas near the sea; the period of life in both is normally one year, but the eggs of the first, if not slightly moistened, retain vitality for years and hatch out when rain falls. This complicates the problem and as both species, when abundant, fly over long distances, the necessity of a joint "Intelligence Bureau" is fully shown.

In 1907-1908 a sum of about Rs. 6,00,000 was spent in the whole area, and this is estimated to be about one per cent. of the damage that the destroyed locusts would have caused had the work not been done. A feature of the year was the extraordinary destruction of the eggs by parasites ("which destroyed quite two-thirds of those laid") in Natal and the amount of good done by locust-eating birds generally. In this connection it is worth note that, at a full meeting of the Committee, it was unanimously resolved that it was impracticable to increase the efficiency of the insect, fungus and other natural enemies of locusts in South Africa, beyond affording protection to the birds and small animals that destroy them, and also that *it would*

do no good to import parasites or other enemies from over-sea countries. This is the definite opinion of a gathering of practical and experienced agricultural entomologists.

Generally speaking, one standard method has been adopted, the application of a strong arsenical solution, sweetened, to the vegetation that the hoppers will eat. In some cases the materials are provided by Government, in others legislation enforces the use of the method. Longer experience of this method is emphasizing the danger of Stock-poisoning, cattle getting access to the poisoned vegetation, but this is a very small item of loss which is expected to disappear with practice.

The 1908-1909 report shows that the poisoning method remained in force and that the value of another method, where it was practical, had become established; this was to drive the hoppers into dry grass and burn it. The report states "of such high importance is the last-mentioned measure, that whenever feasible, patches of old grass should be preserved for the purpose when an appearance of voetgangers (hoppers) is anticipated." An improvement made in the poisoning was to issue a concentrated sweet arsenical solution, rather than to issue the white arsenic, soda, and sugar to prepare it on the spot.

Three years of experience of this method since the Locust Bureau was started has not materially modified it and the Bureau are to be congratulated on having a reliable method for exterminating locusts and upon the extremely useful nature of the work they are doing.—(H. M. LEFROY).

***

LEGUME BACTERIA.—A very interesting pamphlet on this subject by Drs. Edwards and Barlow is published as Bulletin No. 169 of the Ontario Department of Agriculture. Work on the isolation, cultivation, and preservation of nodule bacteria from various leguminous plants has been in progress in the bacteriological department of the Ontario Agricultural College for more than five years and in previous publications (Centrallblatt für Bakteriologie, II Abt., Vol. 19, 1907), the results obtained

up to 1906 have already been summarised. An account was given of the isolation of B. radicicola from 14 different species of legume belonging to four different genera and the media which had been found most suitable for their cultivation were described.

In the present publication the isolation of the organism from 12 further species, and experiments with modified media are recorded. It is found that for general purposes media of the following composition give the most satisfactory results :—

Water	100 parts.
* Ash	·4 to 1 part.
Maltose	·4 to 1 „
Agar	·4 to 1·5 „

It is found that dextrose, mannite, and amygdalin can advantageously replace maltose in solid media, but the substitution of asparagin or inulin leads to very scanty growth, and that of levulose to complete inhibition. In liquid media maltose appears to be the best of a number of sugars tried, and levulose prevents growth altogether just as it does in solid media.

Since 1905, the Ontario Department of Agriculture has been distributing cultures of various nodule bacteria on an ash-sugar-agar medium to farmers for the inoculation of crops. In this connection an account of a series of experiments, which is in progress, on the vitality of the bacteria in cultivation on this medium and on seeds after inoculation with the culture is most welcome. Investigations on these points, which are fundamental to any possibility of the distribution of cultures for inoculation being a practical success, have been conspicuous by their absence in the many publications on the subject which have recently been issued. The Ontario observers show that cultures on their medium have remained alive for well over a year in nearly every case and, in some instances, for two, or even three, years, and that a considerable number of the bacteria remain alive on the seed, after inoculation and drying, for periods up to 13 days. Furthermore they have satisfied themselves that the inoculated

* The ashes from maple or mixed beech and maple, from elm, and from tamarisk, were used with equally favourable results.

seed sown by the farmers to whom the inoculating material was sent did actually bear living bacteria by collecting samples of it from a large number of them and finding living bacteria in considerable numbers still present.

So far this is all very satisfactory; but what one feels is lacking in the Ontario experiments, as in most others which have been carried out on the same plan in other parts of the world, is sufficiently satisfactory evidence that any benefit has actually been derived from inoculation. During the four years 1905-1908, 3,106 cultures were issued to farmers; of these only 1,012 (or about 32·6 %) sent in reports to the Agricultural Department and only 627 (or about 20%) recorded successes. Now, disregarding the probability that a farmer would more readily send in a report if he had to record a success than a failure, let us assume that the same proportion of those who did not report, obtained successful results as of those who did so. On this assumption we conclude that, out of 3,106 cultures issued 1,309 (or about 42%) led to positive results; a very small proportion if we are to believe that inoculation is likely to be of anything like universal benefit and that the experiments were accurately carried out and recorded. But in this latter reservation lies the whole difficulty of the case. The appeal to the practical man is the order of the day in agricultural experiments, and, naturally, the ultimate verdict as to the value of any new practice introduced into agriculture by science must rest with such appeal; but it is, to say the least of it, extremely doubtful whether the appeal should be made until very searching practical tests have been carried out by fully qualified investigators. The difficulties of carrying out comparative experiments in agriculture accurately are so great that, in a matter of the sort we are dealing with, the results recorded by farmers are not likely to be worth much, and we should have welcomed some figures bearing on the practical application of the cultures derived from experiments carried out by Drs. Edwards and Barlow themselves. It may be that some special advantage attaches to their method of preparing and preserving their cultures. Cultures prepared and preserved in

different ways have not, so far, given anything like uniformly satisfactory results in the hands of competent investigators in other countries, and we should have liked to see some really reliable evidence of the relative value of the Ontario preparations from the practical standpoint.—(C. BERGTHEIL).

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